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No. 11

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This report contains information on national-level science policies, technology strategies, and research and development programs in West European science and technology in general and specifically in civil technology, with particular attention to transportation, energy, chemical manufacturing, industrial automation and technology transfer. The report will focus primarily on France and the Federal Republic of Germany, but will also cover important developments in Italy, the Netherlands, Sweden and other West European countries.

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SCIENCE AND TECHNOLOGY

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EUROPEAN COMMUNITIES' R&D ACTIVITIES, PLANS EXAMINED

R&D Expenditures Since 1970

Paris AFP SCIENCES in French 11 Oct 79 p 3

[Text] Brussels--EUROFORUM, the Economic Commission for Europe (EEC) weekly published in Brussels, is of the opinion that, since 1979, the EEC countries have not on the whole granted enough credit for research.

However, expenditures for research and development in the EEC are being laid out at approximately the same rate as in the United States in real terms, or 3 percent.

The EEC devotes 1.02 percent of its gross national product to research as against 1.22 percent for the United States. From 1970 to 1977, Ireland increased its allotments of credit for research by 16 percent, Italy by 8 and France and Germany by 5 and 6 respectively. As far as per capita research credits are concerned, Germany heads the list, followed by France and then the Netherlands.

Support for Offshore Research

Paris SEMAINE DE L'ENERGIE in French 4 Oct 79 pp 4-5

[Text] The EEC has just presented its proposals for the financing of 1979 (first part) offshore technological research to the council. The council could adopt them at its coming 9 October meeting. According to the commission proposals, the EEC should provide a total of 22.5 million UC (1 Unit of Account = 5.75 French francs) for altogether 24 projects of interest to the four "big" European powers: France, Italy, the United Kingdom and the FRG. In terms of percentages and in comparison with last year, France has consolidated its lead by obtaining 37 percent of the credit allotted (up 2 percent), Great Britain has fallen back (23.5 percent, or down 6 percent), the FRG remains stable (at 10 percent) and Italy leaped forward with 29 percent (up 13 percent).

Included among the heavily subsidized projects are: completion of work on composite offshore deep-foundation structures (Wimpey, Great Britain, 1.6

million UC), cryogenic extraction of CO_2 from natural gas (SNAM [National Gas Pipeline Company], 1.5 million UC), improvement of the secondary recovery system (1.7 million UC, AGIP [National Italian Oil Company]) and various projects dealing with the repair and/or checking of deeply laid pipelines (Gerth, 1.7 and 1 million UC; SNAM, 3 million UC). A second block of credits will be granted next December.

Future of Offshore Financing System

The offshore technological research aid program is probably going through its final stage and should, according to responsible officials, disappear in 2 years.

Thus the 1980 budget, originally set at 20 million UC, will come to only 15 as against 38 in 1978 and 50 in 1977. Working against it are the election of the new European Parliament (less attuned to this problem than the last one) and a loss of interest in it on the part of the council and the commission which feel that the objective (completion of offshore technology research) has now been achieved.

However, financing for this sector will not be eliminated. Reactivation of an old project, buried in 1973, for the subsidization of exploration operations is at present being discussed in Brussels.

New Directions, Programs

Paris SEMAINE DE L'ENERGIE in French 25 Oct 79 pp 3-5

[Text] On Monday, 22 October, the European Research Council held its session in Luxembourg. It had to decide on three important issues, to wit:

1. The Research and Development (R and D) Commission program, for which the commission hopes to work out a budget that will increase from 800 million to 1.85 billion UC, half of which is to be devoted to nuclear safety.

2. The second thermonuclear fusion program for 1979-1983, which follows a first program for 1976-1980, is designed to pursue the development of the science of the magnetic confinement of plasmas along with the United States, Japan and the Soviet Union. This program consists of two parts:

The European JET (Joint European Torus) program under construction at Culham (Great Britain), for which the EEC is to pay 200 million UC.

The integrated program being conducted in member states as well as in Sweden and Switzerland, which combines all fusion activities by these countries. The EEC is to participate in these programs to the extent of 200 million UC (total cost: 745 million UC).

3. The Joint Research Center's (CCR) second program (see report below).

The balance sheet for this meeting: two minor decisions on research programs for the recycling of household and industrial waste (9 million UC in 4 years) and the storage of and administration over nuclear waste (43 million UC in 4 years).

The general R and D program was not passed on since the ministers wished to concentrate more on these priorities.

The second CCR program has been conducted by France and Great Britain, which feel that Project "Supersara" in Italy is superfluous.

Italy appears to have linked this CCR program with the fusion program, which has therefore also been renewed.

In short, the three main avenues of joint research are blocked, national considerations appear to have won out over research properly speaking and it is hard to imagine how the ministers can find a common ground between now and the next council session, to be held in December

Report on Activities of the EEC's CCR

The EEC has just published the report on the 1977-1978 activities of its CCR. The CCR, which consists of four centers located in Italy, the FRG and Belgium, has been operating without interruption since 1959 with the exception of the 4-year "freeze" brought on by the Euratom crisis (1968-1972).

At present research involves five priorities among which are two energy domains: nuclear safety and new sources of energy.

Nuclear safety is the top priority. To Mr Guido Brunner's way of thinking, it constitutes the necessary counterpart of the national programs for the construction of nuclear power plants in order to avoid accidents with serious consequences as well as to win public opinion over to the cause of nuclear energy... and of Europe.

Also the credits allotted for this research will be doubled during the 4 years to come, amounting to 156 million UC. The research will be chiefly conducted at the Istra Center (Italy) which has at its disposal an Essor research reactor. The latter was to form the basis for Project Supersara involving a simulated power plant accident.

In the domain of substitute sources of energy, the CCR can claim credit for a world premiere in the field of thermoproduction of hydrogen and the realization of the Esti project for the study of solar energy.

Short-Term Future of EEC Coal

On the occasion of the 25th anniversary of the creation of the Committee on "Coal" Jobs on 19 October, European Energy Commissioner Guido Brunner delivered a speech in Saarbrucken on the future role of coal in the European energy market.

According to the commissioner, "jobs in the coal industry have not been as secure as they are today in 20 years" and coal will begin to replace oil products and perhaps even natural gas in 5 years at the latest. World oil prices and shipping terms will at that time justify the utilization of coal to obtain oil, gasoline and gas. In preparation for that time, the countries of Europe have annually invested almost 6 GF [expansion unknown] in the coal industry. While investments in the hydrocarbons industry have dropped by a quarter of what they were, those of the coal industry have advanced by 30 percent and unsold inventories have returned to satisfactory levels.

The commissioner warned the industry against the temptation of shunting world market coal to the sidelines. According to him, "whoever is in favor of having coal play a dominant role in supplying Europe with energy cannot help but have to resort to imported coal," if only because this world coal market, essentially based in Poland and South Africa, is very limited (12 percent of the coal mined) and "everyone would be well-advised to cultivate relations with these exporting countries as of now."

Mr Brunner called on the coal industry to massively invest in more effective production techniques by taking advantage of European aid — as now planned — and of "the EEC's excellent credit standing in international capital markets."

Mr Brunner felt he ought to raise the possibility of a European loan for the same type of energy as the Euratom loans, designed to support programs for the construction of nuclear power plants.

And lastly, he reminded us that a revival of the European mines would only take place with the introduction of new technologies, therefore involving research in which Europe ought to play a leading role. In the course of the next 4 years 550 million francs are to be allotted by the EEC for technological research on coal.

11,466
CSO: 3102

FRANCE, NORWAY COOPERATE IN UNDERSEA PIPELINE TECHNOLOGY

Oslo AFTENPOSTEN in Norwegian 20 Nov 79 p 27

[Article by Svenn R. Helskog: "New Technology for 1000 m Depth: French - Norwegian Drilling Ship for Deepwater Pipe Laying"]

[Text] The Norwegian drilling ship "Pelerin," which has already performed drilling for oil at a depth of 1000 m, can also be used as a pipe laying vessel. Included in a 250-million-French-franc research program is also a number of experiments in laying large-diameter oil and gas pipelines at an ocean depth of 1000 m. It is the French Total oil Company which has initiated this research program, which will be concluded at the turn of the year in 1981/82. Included in the program also are connections and repairs at a depth of 1000 m.

As we know, it has already been shown by a number of tests that it is possible to lay pipelines across the Norwegian Channel. The depth here is about 300 m. At a depth like this it is still possible to use conventional laying methods.

"Pelerin"

The Frenchmen's idea is now to use the drilling ship "Pelerin" as a pipe laying vessel. The technology which is used is called the "J-curve method" and consists purely and simply in the fact that the pipes are dropped down through the open "well" under the derrick. The derrick, or slide through which the pipe is guided down, is placed at an oblique angle above. The welding together of individual lengths of pipe is performed by a newly developed welding method based on electron beams, and it is 10 times stronger than conventional welding.

The "Pelerin" is a so-called dynamically positioned vessel, which is to say that it does not need anchors in order to maintain its position. This is accomplished by means of the ship's many propellers fore and aft and on both sides of the hull.

Pipe-Laying in Bad Weather

As the ship moves forward, the lengths of pipe are dropped out in the usual manner. Research results have already indicated at this time that such a method can be used even in very severe weather, and that it can be possible to lay pipes all the way down to a depth of 3000 m.

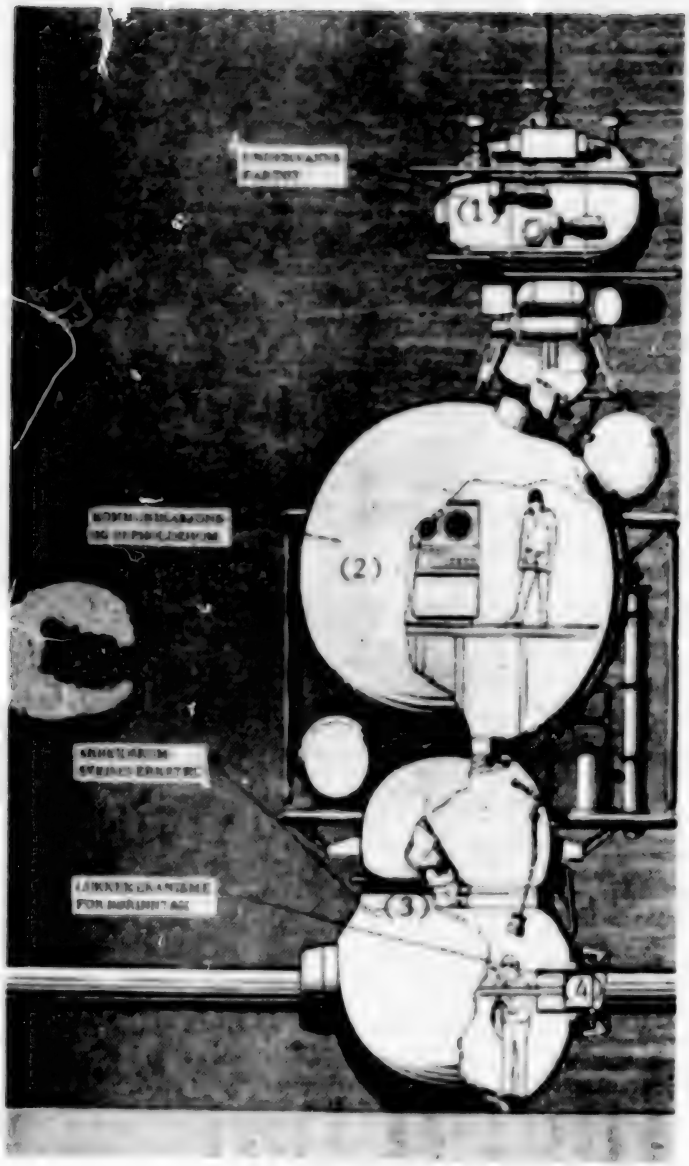
At an ocean depth of over 300 m, problems relating to connection and repairs arise with full gravity. At a depth of up to 300 m one has equipment for so-called "hyperbaric welding," or welding and other work under a pressure of 1 atm. But when the water depth becomes greater, this equipment no longer suffices.

New System for Repairs

In the same research program, Total has built a model of a system which will make such work possible at a depth of 1000 m. The system has been given the name "Weldap." A full-scale experiment was conducted in Norwegian territory last February at a depth of 300 m. A 20-inch pipeline was connected twice. Both experiments were successful, says "Deep Sea Pipelines" Project Leader Bruno de Sivry.

The system consists in the fact that a "bell" is lowered over the pipeline's two end pieces. Above the "bell" are located a workshop and a living area for those who will work on the pipeline. Personnel and materials are transported down to the work place by means of a submarine, and the entire operation thus takes place under a pressure of 1 atm.

When it is question of repairs, the damaged section of the pipeline is located by means of the submarine. The "bell," which now also has a piece of pipe down with it, is lowered over the damaged section, which is cut away. The new section is lowered into place, welded, and is given a new anti-corrosion coating and concrete cover. When the working "bel" is removed, the section of pipe is buried again. This is the safest way one can repair a damaged pipeline, because there is always the danger of further damage if the pipeline must be hoisted up from the bottom in long lengths.



The French "Weldap" system is intended for a water depth of over 100 m and is included as a necessary link in the search for and production of oil and gas at great sea depths.

Key:

1. Submarine
2. Communications and living area
3. Workroom/welding shop
4. Locking mechanism for pipe inlet

Total has in cooperation with other French companies also developed methods for the production of oil and gas on the ocean floor, also at extremely great depths, and designed for areas where conditions are very difficult.

So, the French can introduce a fully developed technology for both exploratory drilling for oil and gas at very great depths, and for production on the ocean floor and transportation to land through pipelines across water depths which hitherto there has been little willingness to tackle.

As oil operations move northward and into deeper and more difficult waters on the Norwegian continental shelf, we will be going to need this technology, which enables oilmen woth to overcome what were hitherto considered significant obstacles, and to meet the safety requirements which it is necessary to establish and stick to.

8985
CSO: 3102

TECHNICAL, COMMERCIAL FUTURE OF ARIANE PROGRAM

Paris L'EXPANSION in French 9-22 Nov 79 pp 133-137

[Article by Jacques Fontaine: "France Launches Into Space"]

[Text] Some morning in mid-December, Alexandre Merdrignac and Jean-Pierre Rouzeval, operations directors of the Kourou (Guiana) Space Center, will release the thrust of the Ariane rocket's first stage which is four times more powerful than the Concorde. In so doing, they will not only be launching into space 180 tons of fuel housed in some 20 tons of advanced-technology machinery and electronics. They will also--if everything goes well--be raising the curtain on a major premiere, namely the coming-to-age of a European space industry.

With Ariane, the conquest of space by Europeans actually passes from the era of administrators and researchers into the era of managers and salesmen. In January 1980, a private commercial firm, Ariane-Space, will also be "placed in orbit" with the mission of handling regular Ariane production and sales and, hopefully, ensuring the product's profitability. It is believed that at least some 40 Arianes will be launched in the coming 10 years.

Within the next 3 years, 8,000-10,000 persons will be employed in space-related activities in France. By 1985, the total volume of business done by space activities--50 percent launchers, 50 percent satellites--could amount to 5 billion francs per year in France alone. This is not as much as Renault, of course, but it is already more than CII [International Data-Processing Company]-Honeywell-Bull.

France's space industry is, therefore, a full-fledged industry with acknowledged markets, an industry satisfying evident needs with a highly suitable product. In this industrial sector replete with pitfalls for advanced-technology industries--nuclear, electronics, and aeronautics--and filled with short-lived successes and braggadocio when in a fix, France, which has run the whole show, is now giving itself a new chance to prove that it is finally able to control the most difficult factor, namely a strategy.

By drawing a parallel with the Airbus transport's odyssey, one can fully understand the Ariane story. Like the Airbus program, the Ariane project

has succeeded in getting several European countries and some 60 European firms to work together in harmony. The French industrial participants include inter alia, Aerospatiale, Matra, Air Liquide, and SEP (European Propulsion Company). There is no denying that the European space effort, once at death's door, has since come a long way.

After the first sputnik in October 1957 and the first commercial [communications] satellite, the Early Bird, in April 1965, French technology placed its small A-1 satellite in orbit in November 1965, and thereby succeeded, in the wake of the Russians and Americans, in crossing the triple threshold of space qualification: escape velocity, guidance accuracy, and equipment reliability. But the performance characteristics of the Diamant rocket and the resources of its prime contractor, CNES (National Center for Space Studies), were inadequate for any possible commercial applications. Inasmuch as European projects were all the rage, a multinational and two-headed space organization was confirmed by treaty: ELDO [European Launcher Development Organization] for launchers and ESRO [European Space Research Organization] for satellites. This dual organization began development and production of a large rocket proudly christened Europa.

No Space Independence Without a Launch Vehicle

Europa will undoubtedly go down in history as the classical example of the Babelic principle applied to advanced technologies. Europa's three stages--British, French, German, plus an Italian component--functioned efficiently separately but stubbornly refused to work together. The Europa program's managers were described by a participant in that program as "a cohort of diplomats and former generals of the army of the Indies." They had no technical or financial control and were primarily preoccupied with getting an "equitable return" for their national industries. They ultimately had no choice but to conclude that the program was a failure. Yet without a launch vehicle, there can be no possible independence in space matters. This was quickly realized in 1974 when the Franco-German Symphonie communications satellite was ready for launch but the Europa launch vehicle was not. The Americans agreed to launch Symphonie on the express condition that it must not be operated commercially in the international market. This was absolute proof of the United States' commercial imperialism.

By using the wreckage of the Europa rocket and the lessons learned from the mistakes made with that program, France was able to persuade its partners to approve the Ariane launcher project in July 1973. France and these partners subsequently formed a new organization, the European Space Agency (ESA). CNES served as Ariane's single program manager and prime contractor with complete authority in all technical, financial, and planning matters. Aerospatiale functioned as Ariane's single industrial architect with responsibility for not only the first two stages but also integration of all systems. A carefully designed plan established target dates and costs from the very outset and was soundly implemented with production contracts. In short, an organization was formed in which France, more experienced particularly

because of its military missile programs, unquestionably was the major participant: 65 percent of the financing versus 20 percent by Germany, the second largest contributor. It was also a smoothly functioning organization because all tasks were very clearly apportioned from the outset on the basis of capabilities and also competitive bids, thereby eliminating any possible subsequent political haggling over equitable return.

As was the case with the Airbus program, the Ariane program deliberately used solely tried-and-true technologies, except possibly for the third stage which uses liquid oxygen and liquid hydrogen as propellants, a relatively new concept in Europe. Reasonable performance goals were also set for the Ariane rocket. Actually, however, design performance characteristics steadily improved as development and production of the rocket progressed, something that is not usually the case. The program's primary objective was to produce a reliable and relatively inexpensive launch vehicle when and as needed. Ariane's industrial philosophy can be expressed in one word, credibility.

To continue our comparison of the Ariane and Airbus projects, it should be noted that in certain respects Ariane goes even further than Airbus. For instance, the engines of the Airbus aircraft are American, whereas the Ariane launcher is practically 100 percent European. Airbus Industrie, the program's industrial and commercial organization, is simply an economic interest group (GIE), whereas Ariane-Space is a regular private corporation. Lastly, there is a larger number of countries (11) in the Ariane program than in the Airbus program.

"Space Market Growing at Very Rapid Rate"

So today an Ariane rocket towers some 47 meters high on its launch pad against the backdrop of a tropical forest. Before its very first flight, we shall here endeavor to assess the importance of this product we are being offered.

The prime contractor has demonstrated its management capability. The 1973 program called for the first launch to be conducted in July 1979 with the rocket becoming operational in late 1980 after four test shots. It can now be said that there is every chance of meeting that target date. Ariane's total estimated budget was 2 billion francs--nearly 4 billion francs at today's prices--plus an additional 20 percent for contingencies. The program will remain within that budget and is not even expected to expend all of its contingency funds.

Ariane is being introduced at the right time. "The situation has developed very rapidly over the past 2 years," Jean-Gerard Roussel, CNES director for international and industrial affairs, told us, "and the space market is growing at a very rapid rate."

At the present time, that market--exclusive of military applications--consists mainly in launching communications satellites (for voice, video, and soon high-speed data transmissions). Early Bird has had many continuously improved descendants and imitators, some of them servicing a single country

--the United States, USSR, Canada, and Indonesia--while others, such as Intelsat's satellites, form an international network. Intelsat, an international but American-dominated organization, is an extremely profitable business for the very good reason that transmission via satellite is much cheaper than via landlines. Intelsat's volume of traffic has been rising 18 percent per year.

The number of satellite projects is increasing throughout the world. For instance, France is developing two Telecom--high-capacity and high-speed data transmission oriented--satellites to be operational in 1982-1983, and the European organization of national telecommunications administrations has ordered five regional communications satellites (ECS) with the first due to be launched in 1981. These satellites constitute a ready-made market for the six first operational Ariane launch vehicles now on order.

European programs also cover other satellite applications: earth resources observation (French SPOT satellite), meteorology (European Meteosat satellites), scientific research, maritime navigation, etc. The direct television broadcast satellite is no doubt ultimately the most promising development. Instead of connecting two points, this satellite will broadcast directly to the public's television receivers. Helmut Schmidt and Valery Giscard d'Estaing are known to have agreed in early October that France and Germany would build such a satellite. Present plans call solely for experimental and demonstration systems. The shift to commercial operation will run into a serious politico-juridical "muddle" in our country. But the economic and technical advantages of direct broadcast television are immense, especially for large-sized countries, and Europe will thus be in a position to offer a system complete with satellite and launcher.

A market study shows that a total of 223 nonmilitary satellites are expected to be launched throughout the world from now until 1990, including replacement satellites (average service life of a satellite is 7 years). Considering the captive markets--American and European--and the competitive conditions in all remaining markets, it is estimated that Ariane could launch from 40 to 51 of these 223 satellites.

Ariane is lucky. Almost all of the non-Russian satellites currently in space were launched by American Thor-Delta and Atlas rockets. Ariane's capability of placing 1,700 kilograms into geostationary transfer orbit is comparable to the more powerful of the two American launchers, the Atlas. There is no common measure, however, between Ariane and the latest American marvel, the space shuttle. Above all, the shuttle is reusable, a fact that its promoters claim should enable it to offer an unbeatable deal in terms of launch fees.

Space Shuttle Delay Opens Door to Ariane

It might appear, therefore, that Ariane has lost this battle before it even starts. There is one hitch, however: the shuttle is behind schedule. Unlike

Ariane, the shuttle is an extremely technologically ambitious project because NASA, after Project Apollo, needed a "grand design" to hold the attention of its personnel, crews, and public. Nevertheless, the shuttle's engines--four times more powerful than the Saturn's engines--are not running smoothly, there are problems with the adhesiveness of the thermal protection system's silica glass fiber tiles, costs keep climbing, Congress is grumbling, and there is no certainty that the first flight, already postponed, can take place in 1980. There is nothing dramatic about these problems per se, except for the fact thatthey do open the door wide to Ariane because the United States, counting on the shuttle, has stopped production of Atlas launchers.

Moreover, the space shuttle formula does have its shortcomings which Ariane salesmen have carefully catalogued. Because of the miniaturization of electronic equipment, practically no commercial satellite now exceeds Ariane's payload capability. Thus by a happy coincidence, Ariane currently qualifies as an excellent "taxi rocket." The shuttle, on the contrary--except for certain heavy scientific missions like Spacelab--is condemned to serve as a "bus" in order to be profitable, and there is no assurance that its passengers will readilyget on well together. Furthermore, although retrievability is an advantage, it does not apply to the shuttle system in its entirety and is not gratis. How many times can the boosters recovered at sea be used again? Lastly, technicians explain that because Ariane's launch site is on the equator, it is better adapted to insertion into geosynchronous orbit than the shuttle.

Of course, all this was not foreseen back in 1973, and the Ariane project was not approved on the basis of such uncertain calculations. As explained to us by Jean-Claude Pelissolo, director of electronics and data processing industries in the Ministry of Industry: "At that time, Europeans considered Ariane to be at least an instrument of deterrence and negotiation, and at best a means of launching their own satellites. It was only along the way that we discovered it could be sold on the basis of its own capabilities and be competitive with standard launch vehicles and even with the shuttle. Hence, the door now open to us is not merely a temporary situation." A lucky break: Ariane's promoters were seeking independence and they achieved competitiveness.

For Ariane is indeed competitive. Striking proof of this was furnished last year when Intelsat, without even waiting for the outcome of Ariane's first test shot, contracted for two Arianes (one firm order and one option) instead of for an American rocket to launch the Intelsat 5 and 6 satellites. Launch fee: 25 million dollars for the first satellite and, paradoxically enough, more for the second when the option is taken up, as is expected. Because of the scheduled launch dates of these two satellites--1981 and 1982--the delay in the space shuttle's availability was undoubtedly a factor. Nevertheless, an Ariane launch was deemed economically feasible by an organization in which, to say the least, there was no prejudice in favor of Ariane.

The launch fee of 25 million dollars, a little more than 100 million francs, is an "introductory" price. A more realistic price would be 150 or 175 million francs, "a price that would enable us to balance our budget," explained Frederic d'Allest, director of launchers for CNES, but which, nevertheless, does not permit recoupment of research and development costs (yet isn't this the general rule in advanced-technology and prestige projects?). Hence the major problem facing the new commercial firm, Ariane-Space, is the establishment of a pricing policy that will answer the following questions: How much of the firm's actual costs must be recouped? What constitutes an acceptable dumping level? In discussing this pricing problem, Jean-Claude Pelissolo explained: "Actually there are three conceivable price levels. The highest would be the one for independence in autarky, without any exporting. The lowest would consist in conforming to the international reference, in other words to whatever the Americans decide. We shall follow an intermediate policy, at least initially, whereby Europeans will pay slightly more than the world price established for the shuttle. This is not dumping: by exporting at the marginal price, we thereby broaden the market and ultimately spend less for each launcher than under an autarkik policy."

Other versions of Ariane are to be developed. The initial launcher was wisely designed so as to make it technologically easy to develop improved versions. The currently programmed Ariane 3 version will be capable of simultaneously launching two communications satellites by about 1983. A subsequent version, now on paper, would be able, in some 10 years, to put a small shuttle-type vehicle, a sort of Apollo glider, into a low orbit.

Commercial Battle With Shuttle

A more suitable organization has been formed to handle these products. Frederic d'Allest explained: "The European Space Agency operated satisfactorily as long as the task was one of formulating and directing a development program. But for production and marketing, the decision-making machinery has to be more rapid and flexible." Did it not take ESA 3 years to conclude the agreement on production of the first six operational launchers? Thus at this summer's Paris Air Show, formal announcement was made of the formation of Ariane-Space, a commercial organization based on a plan followed a few years ago by the French Atomic Energy Commission. Ariane-Space is a French corporation with capitalization of 150 million francs. It will build and market Ariane launchers, with ESA and CNES retaining responsibility for research and development of any subsequent versions. This new commercial venture has some 40 shareholders. CNES is the principal shareholder, owning 34 percent of the shares. Others include industrial firms participating in Ariane production plus a number of banks, such as Credit Lyonnais, BNP [National Bank of Paris], Paribas, and the Dresdner Bank. There will be risks involved....

In summary: by 1 January 1980, the first Ariane will have been launched, regular production of operational launchers will be underway, an efficient European management organization will be established, and work will have begun on production of Ariane 3. As the United States' sole competitor,

Europe, unquestionably led by France, will be in a position to offer countries of the world a complete package of space equipment and services: launcher, launch complex, a fine collection of satellites, ground receiving stations, and technical assistance.

What could possibly spoil this idyllic picture? First of all, Ariane must obviously not come to grief on its first test launch. We shall soon know whether it does or not. When we posed this question to the scientists and engineers we interviewed in preparation for this article, it was fascinating to see the gleam of old superstitutions in their eyes. As a researcher from ONERA (National Office for Space Studies and Research) told us: "In this business, even if all the components and subassemblies have been tested one by one, there can be no dress rehearsal. The first real test is the launch itself." He then reminded us that the Titan rocket which was eventually responsible for the success of Project Gemini, had had eight failures in its first 14 launches. If two of the four Arianes perform well in their test shots, that will not be considered a failure. Three satisfactory launches out of four will be considered a success. Nevertheless, it would be psychologically better not to begin with a "flop."

After these test shots will come the commercial battle, but not with the old Atlas Centaur rocket, definitely surpassed by Ariane not in performance but in cost. Ariane's battle will be with the space shuttle.

In the long run, the shuttle's capabilities will no doubt enable it to monopolize such major futuristic applications as space exploration, processing of materials in weightlessnes, and solar power satellites. In the shorter run--he who can do more can do less--the shuttle's capabilities will undoubtedly enable it, at a price, to bar Ariane from all noncaptive markets. William Dean, vice president of Lockheed International, the shuttle's prime contractor, described it to us in glowing terms: "The shuttle will be the DC-3 of space! It can do everything. There will be no need for anything more for the foreseeable future." He conceded, however, that "for small payloads" Ariane could offer "some sort of competition."

Small but Significant Share

Actually, everything will depend on what strategy the United States follows. The prices Ariane can offer are reasonable. The Americans can beat those prices but, from what we know today about their launcher, there is no assurance at all that they can do so and get off scot free. It is not like the U.S. Congress to subsidize without security an industry in the process of becoming standardized, unless that industry demonstrates its competitiveness. Furthermore, this would give Europe a good opportunity to assert itself politically throughout the world.

What will most likely happen is that after 4 1-2 years there will be a de facto sharing of the world market, leaving to Ariane a small but significant share of probably 20 to 25 percent. A situation similar to the Airbus, as I indicated earlier.

In the meantime, CNES has already started a program designed to cut Ariane production costs systematically. Ariane 3's cost/payload will reportedly be 35 percent less than the current version. There's no doubt about it, our technological and engineering "highbrows" will long remember the lessons learned from the Concorde's mishaps.

8041
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COMPETITIVENESS, PRESENT STATE OF DESALINATION TECHNOLOGY

Paris SEMAINE DE L'ENERGIE in French 8 Nov 79 p 15

[Text] The seawater desalination market, which has been briskly expanding since 1973, is now at a crossroads. Only 4 or 5 of the 10 to 15 processes which were in competition a few years ago still exist. In addition, there is now the new problem of renewing the very earliest units which date back some 20 years.

The fourth international congress on seawater desalination, which took place last week in Nice, gave an opportunity to 500 participants from 42 countries to prepare new prospects for this industry which is already so forward-looking.

Distillation units, representing over 80 percent of the world market, still maintain their advantage with respect to seawater. The proof is the order recently placed by Saudi-Arabia for Al Jubail 2: 40 units with a capacity of 24,000 m3/j apiece, for a total price of 4 GF. But there is still a lot to be done to reduce initial investments as well as energy costs. For France, there is a sizable additional handicap: the lack of competitiveness of French suppliers, in spite of a technology of proven worth.

The process of inverse osmosis, more suitable for brackish water, is also developing well: since 1970, more than 3000 plants have been placed in operation throughout the world, with a market growth of 20 percent to 30 percent per year. However, this progress is finding two obstacles: the still-high cost of initial overall investment, and the too-frequent replacement of membranes.

Buyers are few and demanding. They come from the Middle East, beginning with Saudi-Arabia, in a market worth several billion francs per year. Price is the determining factor, and the Japanese, thanks to prices which are 30 percent lower than European quotations, are winning the bulk of the market. Their power also rests in their ability to furnish complete units, like Mitsubishi and Mitsui.

France, which does not have this advantage, still gets 25 percent of the market thanks to engineering companies such as Sidem and CGA for distillation, or Degremont for inverse osmosis. CNIM, CFEM, Vallourec, and Creusot-Loire are construction firms, while Alsthom-Atlantique, Stein-Industrie, and Technip are suppliers of plants and of complete installations.

The competitiveness of French industry, hampered by this scattering, could be increased with the establishment of complete installation enterprises able to compete evenly with the Japanese, Americans, and Germans. It has been suggested that this task should be entrusted to naval shipyards or to large engineering companies.

According to Mr Giraud, who closed the congress organized by the International Association for Desalination and the Environment (IDEA) and by the Association for Industrial Development (ADI), innovation should make it possible for French industrialists to begin to make headway. The era of gigantic units is over, and it is time now to take up more diversified and flexible formulas.

The minister of industry also is in favor of using nuclear reactors for fueling installations, which consume large amounts of energy. This choice does not exclude project studies based on solar or wind energy. These measures should enable France to escape the danger of saturation which threatens the world market for water desalination.

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INDUSTRY, GOVERNMENT LAUNCH BERLIN RESEARCH CENTER

Berlin DER TAGESSPIEGEL in German 12 Dec 79 p 11

[Article by mk: "Groundstone Laid for Electron Synchrotron BESSY"]

[Text] The outline of the large circular storage capacitor, where superfast electrons are expected to produce light for research purposes in 2 to 3 years, is already visible at the large building site at the corner of Lentzeallee and Dillenburger Strasse in Wilmersdorf. The ground-laying ceremony of the Berlin Electron Synchrotron, called BESSY for short, took place only yesterday during a heavy rain which, to Senator for Science Glotz, was a sign that the weather forecasters harbored no great favor for this new Berlin research center, even though they too may profit from the basic research to be conducted by BESSY. Among others researchers in physics and chemistry will use the synchrotron for the study of chemical reactions which in the end will also help illuminate the chemical reactions taking place in the atmosphere.

The skeleton contract for the construction of BESSY was signed by its various sponsors in March of this year. The innovative construction of the research center as a joint tool for basic as well as applied research for industry made it necessary to found a corporation. The participating industrial enterprises AEG-Telefunken, Eurosil Ltd., Philips Ltd. and the Siemens Company own half the corporation; the other half is owned by the Federal Government, represented by the Ministry of Research and Commerce, the Federal Institute for Technical Physics and the Land of Berlin, represented by the Senat Administration for Science and Research. In addition, part owners of this half are the Max-Planck-Society, the Fraunhofer Society, the Hahn-Meitner Institue and the German Electron Synchrotron.

While BESSY is only in the construction stage the experiments to be conducted there are already being conceived and planned in a number of laboratories; the amazingly broad scope of the experiments was emphasized by BESSY's scientific director Prof Helmut Baumgaertel from the Institute for Physical Chemistry of the Free University of Berlin. Here the synchrotron light irradiated by BESSY, which in other electron synchrotrons serving nuclear research is regarded as a cumbersome waste product, is vital. It is generated when particles accelerated to almost the speed of light are forced into a

curved trajectory. Then they emit energy in the form of synchrotron radiation whose spectrum reaches from the infrared to the Roentgen zone. In addition to the experiments to be conducted by BESSY bearing on chemical reactions basic research involving the physical and chemical characteristics of surfaces will constitute the second focus.

Baumgaertel stressed that these experiments could lead to the improvement of catalysts raising yields of chemical reactions and saving energy at the same time. An example mentioned by Baumgaertel was improved decontamination of automobile emissions. Beyond that basic research in the field of surface characteristics is also a prerequisite for improving optical building elements. Finally, BESSY will also be used for experimental work involving the solution of medical and biological problems. Industry's interest in BESSY is based on the potential of improving miniaturization of electronic circuits by means of Roentgen lithography.

It remains to be seen whether this effort will be crowned by success or whether it will be preempted by competitive efforts under way in the United States. But even then, Senator for Science Glotz emphasizes, the benefits which can be expected to accrue from BESSY in basic research will fully justify its construction. The unique possibilities which BESSY offers the world as a Roentgen microscope available for routine work will further enhance the attractiveness of Berlin as a science center.

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CSO: 3102

UNCONVENTIONAL ROTOR CONSIDERED FOR WIND GENERATORS

Duesseldorf BRENNSTOFF-WAERME-KRAFT in German No 11, Nov 79 pp 441-445

[Article by W.M. Pieper, Giessen: "The Kirsten Rotor as a Windmill"]

[Text] The performance of the Kirsten rotor is calculated for various circumferential velocity to wind velocity ratios and for various blade widths. A detailed description of the kinetic and dynamic characteristics of the Kirsten rotor, and a numerical evaluation of the rotor efficiency equation are given.

Introduction

The Kirsten rotor[1-4] is a rotor with a vertical axis, somewhat similar to the Voith-Schneider propeller[5-8] used in navigation; both have been considered for the utilization of wind energy.[4,9] The Voith-Schneider propeller has also been built as a windmill by W. Just.[10] Kirsten rotor and Voith-Schneider propeller have the advantage of not using twisted, contoured surfaces as rotor blades. However, while the Voith-Schneider propeller requires a complicated control mechanism to position the blade, the Kirsten rotor blade rotates about its own axis once for each half-revolution of the rotor. This makes the blade pitch variation very simple.[2,4] In addition, it generates a high starting torque even at low wind velocities, and therefore could replace the Darrieus rotor.[11] It would also be suitable for the high-altitude wind power stations which have been considered recently, since its blades would also create a lift as in kites.

Kinetic Characteristics of the Kirsten Rotor

Figure 1 shows the principle of the Kirsten rotor when it is provided with only two blades. At each point of the path, the blades are oriented toward A'. The inscribed angle AA'B is therefore always equal to $\frac{1}{2}$/2, i.e. equal to half the center angle AOB. As a result, the angular velocities ω_B of the blades and ω_R of the rotor are related as follows: $\omega_R = 2 \cdot \omega_B$. At each point of the path, the normals to the rotor blades are oriented toward A; one of these normals is shown in E' (Figure 1). At point A, the blade receives the full impact of the wind under a 90° angle of incidence, while at A' it meets the

wind with its front edge. At each revolution, the role of the front and rear edges of the blade are reversed. This has to be taken into consideration when designing the profile of the blade.

Figure 2, on the other hand, represents a Voith-Schneider rotor used as a windmill. Here, the normals to the blades are no longer oriented toward A, but toward N'. Therefore, there no longer exists a common orientation point A' for the blade chords. As a result of the orientation of the normals toward N', the blade at point A offers only its front edge to the wind and does not derive any power from it. In fact, a loss of energy even occurs near point A because of the strong rotation of the blade and the resulting turbulence of the air. It is obvious that the orientation toward N' of all normals to the blades also requires a complicated, power-consuming control mechanism. Let us just mention that, in this rotor, the front edge is always the same and that, therefore, the rotor blade can be given a streamlined profile. Two photographs of a Voith-Schneider windmill are reproduced in reference 9, page 57. In reference 6, the angle ε between the blade of the Voith-Schneider propeller and the tangent to the circle is often indicated. From Figure 1, one can see that in the case of the Kirsten propeller:

$$\varepsilon = 90° - \frac{\phi}{2}$$

For the second half of the blade, 180° must be added or subtracted. In Figure 3, these angles are shown for both types of propellers. One can see that for $-180° \leqslant \phi \leqslant -90°$ and for $90° \leqslant \phi \leqslant 180°$ (i.e. in the left half-circle where $\varepsilon < 0$ in Figures 1 and 2, these angles are in good agreement, while for $-90° \leqslant \phi \leqslant +90°$ the blade of the Voith-Schneider propeller progressively assumes a tangential position: $\varepsilon = 0$ when $\phi = 0$.

When the Voith-Schneider propeller is used as a driving motor, for instance in ships, the normal intercept N' lies inside the circle.

Figure 4 shows how to determine the effective velocity v resulting from the wind velocity w (taken to be in the y direction) and the head-wind which is always tangential, and of velocity u. These vectors are absolutely valid only for the central point of the blade. Because of the rotation of the blade itself, both direction and magnitude of v vary along the blade. This effect is small for narrow blades. We have neglected it here because the drag and lift coefficients of the NACA 0012 profile were available to us only for homogeneous parallel flows. As can be seen, the triangles PQS and PON are similar, and the normal to the resultant velocity v points toward N at all points on the circle. This is true for all rotors the axis of which is at right angles to the direction of the wind. The angle formed by the blade and the resultant velocity v at point P is equal to angle APN which we have called ε. In the upper half-circle ($y > 0$) the flow approaches the blade from the inside of the circle; in the lower half-circle ($y < 0$), it approaches it from the outside of the circle. The angle under which the segment AN is seen gives the angle of attack of the blade. For points on the circle

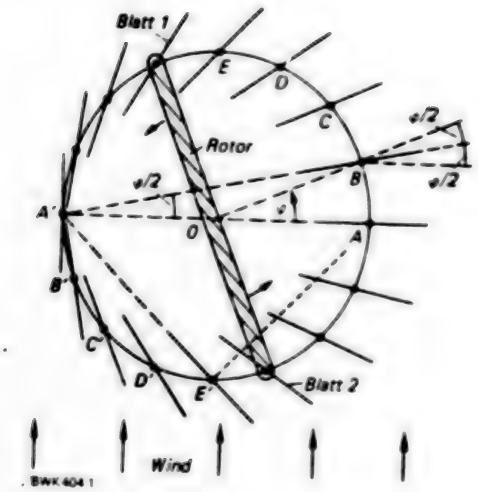

Figure 1. The principle of the Kirsten rotor consists in the permanent orientation of the profile chords toward point A'.

Key: Blatt = blade

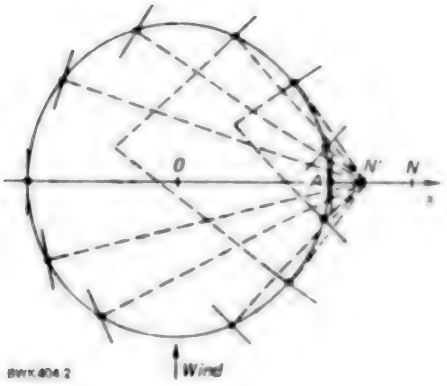

Figure 2. In the Voith-Schneider windmill, the normals to all profile chords are oriented toward N'. As a result, the prolongations of all chords no longer converge toward a single point.

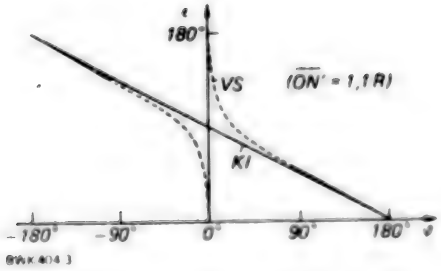

Figure 3. Angles formed by the tangent to the circle and the profile chord, for the Kirsten rotor (KI) and for the Voith-Schneider rotor (VS).

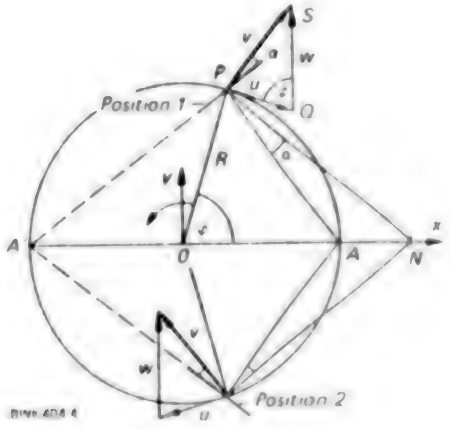

Figure 4. Vector sum v of tangential velocity u and wind velocity w.

in the immediate vicinity of A, AN is seen under an angle of 90°, i.e. the wind arrives perpendicularly to the blade. For points on the circle in the vicinity of A', AN is seen under an angle of 0°, i.e. the wind hits the front edge of the blade. Because of the similitude of the triangles, the radius OP is to the segment ON as u is to w. In further calculations, this quotient is designated by $q = u/w$. The segment ON is then equal to R/q.

The stronger the deceleration of the rotor, i.e. the smaller $q = u/w$, the farther point N moves to the right. Conversely, when the rotor is idling ($u = w$ and $q = 1$, no energy extraction) point N coincides with point A. This gives the Kirsten rotor the great advantage that, during idling, at each point P of the circle the angle of incidence of the flow on the blade is $\alpha = 0°$. The effective wind velocity v and the blade are parallel everywhere. During idling ($u = w$, $q = 1$), the relative velocity at point A is $v = 0$. Therefore, if a storm is too strong and one decides to discontinue the extraction of energy ($u = w = w_1 = w_2$), then practically no wind forces are exerted on the windmill, only the centrifugal and Coriolis forces. To calculate the forces exerted on the blade during normal operation ($u < w$), it is necessary to know the magnitude of the resultant velocity v and the angle of incidence α. The law of cosines applied to triangle PQS gives the velocity of the inflow of fluid on the blade:

$$v^2 = w^2 \, (1 + q^2 - 2q \cos\phi) \qquad (1).$$

As is known, the velocity w of the flowing medium at the windmill is equal to the mean of the velocity w_1 of the free flow far ahead of the windmill and of its velocity w_2 far behind the windmill:

$$w = \frac{(w_1 + w_2)}{2} \qquad (2).$$

In the following paragraph, w is calculated as a function of x. For the angle of attack α of the blade with respect to the velocity v of the flow, we have:

$$\tan \quad = \frac{1-q}{(1 + q) \cdot \tan(\phi/2)} \qquad (3).$$

Even in this analytical form, it can be seen that the angle of attack for each position ϕ during the revolution disappears when $q = 1$. This function, $\alpha(q,\phi)$ is represented in Figure 5. According to it $\alpha(q,\phi) = -\alpha(q,-\phi)$. This illustrates the fact that, at two points P_1 and P_2 on the revolution circle which are symmetrical to each other with respect to the x-axis ($\phi_1 = -\phi_2$), the angle of incidence on the blade is identical, from inside as well as from outside the circle. Therefore, the half-circles $y > 0$ and $y < 0$ contribute equally to the performance of the rotor. Figure 6 shows the velocities of the incident flow for $u/w_1 = 0.7$; it also shows the orientation of the blades toward A'. The length of vector v is given by equations (1) and (9).

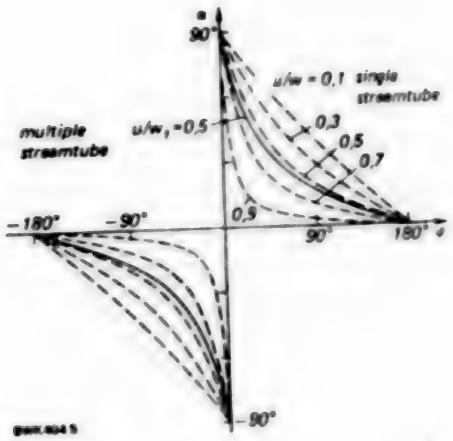

Figure 5. Angle of attack α, i.e. the angle formed by the effective wind velocity v at the blade and the profile chord during one revolution $-180° \leq \phi \leq +180°$, according to equation (3). On the side of the circle facing the wind, α is negative. At the point where $\phi = 0$, the flow approaches the profile under an incidence of $\alpha = 90°$. The broken lines have been determined using constant $q = u/w$ quotients, i.e. for a uniform wind velocity in the circle; the unbroken line corresponds to a wind velocity w in the y-direction, determined by iteration from equation (9) for each angle, using $NC/(4\pi R) = 0.1637$ and $u/w_1 = 0.5$. Then, according to Figure 9, u/w is on the average equal to 0.5/0.9 = 0.56.

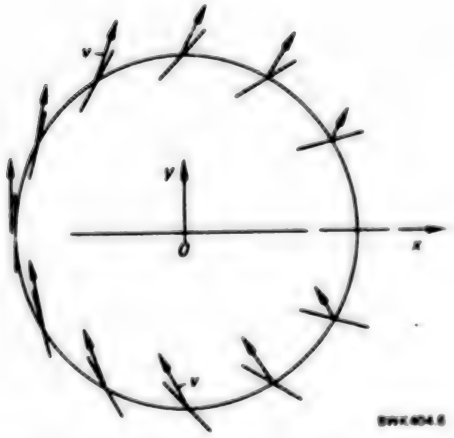

Figure 6. Effective wind velocity $v(\phi)$ on the rotor blade. Valid for $u/w_1 = 0.5$ and $NC/(4\pi R) = 0.1637$.

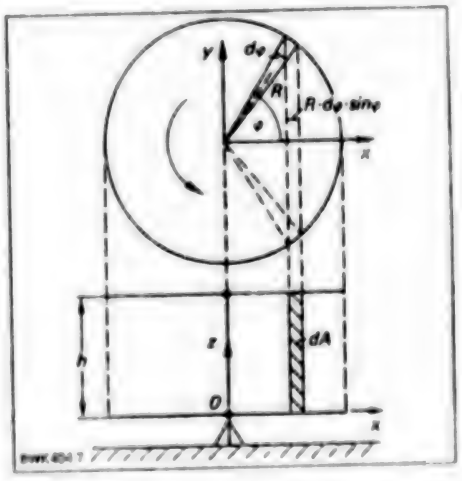

Figure 7. Definition of the cross-section area dA of the streamtube.

Dynamic Characteristics of the Kirsten Rotor

In recent years, two models have been developed to calculate in theory the performance of windmills having vertical axes. Both models have proved valid in calculations relative to the Darrieus rotor. The "single streamtube model"[12] assumes that the wind velocity w remains constant during a whole revolution, while the "multiple streamtube model" decomposes the incident flow into individual streamtubes and calculates their individual decelerations from the aerodynamic forces on the blades.[13] The results given by this second model agree better with the performance characteristics measured in wind tunnels on the Darrieus rotor. Therefore, we have used this model as a basis for our calculations and have selected "streamtubes" corresponding to a rotor height h and a rotor width $R \cdot d\phi \cdot \sin\phi$, Figure 7. Through such areas

$$dA = h\,R d\phi \sin\phi$$

the medium flows with a velocity w which must be calculated for each position ϕ, i.e. for each new value of x. According to equation (2), the overall deceleration $w_1 - w_2$ of the medium is:

$$w_1 - w_2 = 2(w_1 - w) \qquad (4).$$

Therefore, according to the principle of linear momentum, the mass flow ρdAw experiences in the time average the following force:

$$d\bar{F} = \rho dAw2(w_1 - w) \qquad (5).$$

This force is produced by the blades cutting into the domain $d\phi$ on the front and rear sides of the circle. Each of the N blades remains for a time dt in the domain of the "streamtube" $dt = (d\phi/2\pi)T$ on the front and rear sides. All impulses $2NF_y dt$ to be determined aerodynamically are equal to the average impulse $\bar{F}T$, where $T = 2\pi/\omega$ is the time of revolution:

$$2NF_y(Td\phi/2\pi) = T\rho dAw2(w_1 - w).$$

Thus, one obtains the equation of condition for $w(\phi)$:

$$\frac{NF_y(\phi)}{2\pi\rho hR\sin\phi w_1^2} = \frac{w}{w_1}\left(1 - \frac{w}{w_1}\right) \qquad (6)$$

by determining the y-component of the total force on the rotor blade. For an airfoil, the drag force F_w in the direction of flow (parallel to v) and the lift force F_a perpendicular to the latter, are usually given by the respective coefficients:

$$F_w = \frac{1}{2}\rho A v^2 c_w(\alpha)$$

$$F_a = \frac{1}{2}\rho A v^2 c_a(\alpha) \qquad (7).$$

If both forces are decomposed into their x and y components (Figure 8), the value obtained for a blade having a profile chord length C and a surface area A = hC is as follows:

$$F_y = F_w \sin(\alpha + \phi/2) + F_a \cos(\alpha + \phi/2) \qquad (8).$$

If we combine equations (1), (6), (7) and (8), we obtain the equation of condition for $w(\phi)$:

$$\frac{w}{w_1} = 1 + \frac{NC}{4\pi R \sin\phi}(1 + q^2 - 2q\cos\phi) \times \left(c_w(\alpha)\sin\left(\alpha + \frac{\phi}{2}\right) + c_a(\alpha)\cos\left(\alpha + \frac{\phi}{2}\right)\right) \qquad (9).$$

This equation cannot be solved for w because $q = u/w$ and $\alpha = \alpha(q,\phi)$ are dependent on w. It has been solved iteratively for various values of $u = R\omega$ and ϕ. The solutions are shown as $w(x)$ in Figure 9. In the Darrieus rotor[13], this velocity distribution is also dependent on the z coordinate due to the curvature of the blade.

According to equation (1), when $w(\phi)$ is known, so is the effective velocity of the medium on the rotor blade, and the rotor efficiency can be calculated. Now we can also calculate, according to Figure 8, the tangential component F_t of the wind velocity on the blade:

$$F_t = F_w \sin(\alpha - \phi/2) + F_a \cos(\alpha - \phi/2) \qquad (10).$$

The angle formed by the total force and the tangent to the circle is $\alpha - \phi/2$. If one considers that the front and rear half-circles deliver the same amount of energy--the effect of the traveling of the pressure center cancels itself entirely for each full revolution--, the efficiency of a N-blade rotor is as follows:

$$P = \frac{1}{T}\int_{-\pi}^{\pi} M(\phi)d\phi = \frac{1}{T}\,2\int_{0}^{\pi} M(\phi)d\phi = \frac{\omega}{2\pi}\,2N\int_{0}^{\pi} RF_t(\phi)d\phi.$$

Finally, using equations (1), (7) and (10), and taking into account the tangential velocity $u = R\omega$ and the blade surface area $A = hC$, we obtain:

$$P = \frac{1}{2\pi} NCh\rho u \int_{0}^{\pi} d\phi w^2(\phi) \times (1 + q^2 - 2q\cos\phi) \times$$
$$\times (c_w(\alpha)\sin(\alpha - \phi/2) + c_a(\alpha)\cos(\alpha - \phi/2) \qquad (11).$$

In the literature, the efficiency coefficients:

$$c_P = \frac{P}{\frac{1}{2}\rho A_o w_1^3} \qquad (12)$$

are often given in relation to the total efficiency of the undisturbed medium in the domain of the rotor blade $A_o = h(2R + C/2)$.

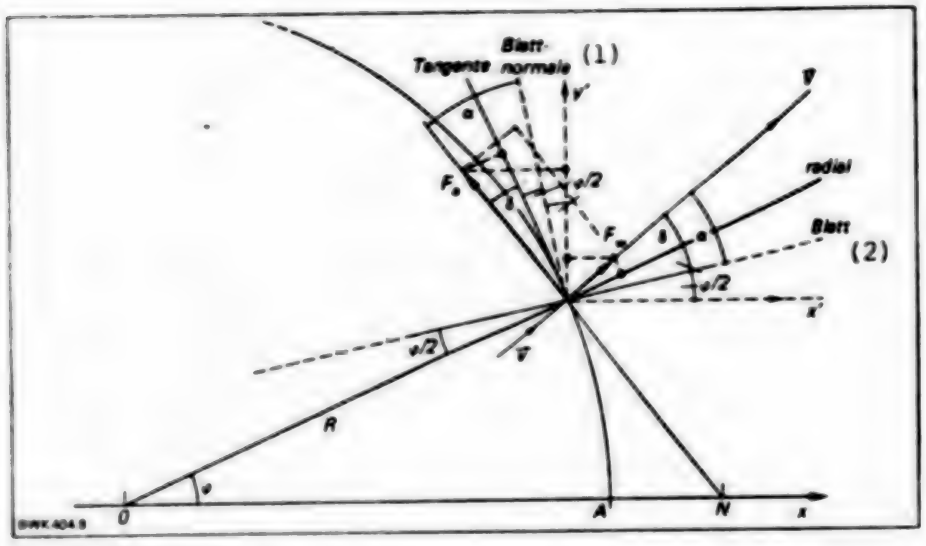

Figure 8. Determination of the y-component of the total force F resulting from the lift and drag forces, respectively F_a and F_w.

Key: 1. Normal to the blade 2. Blade

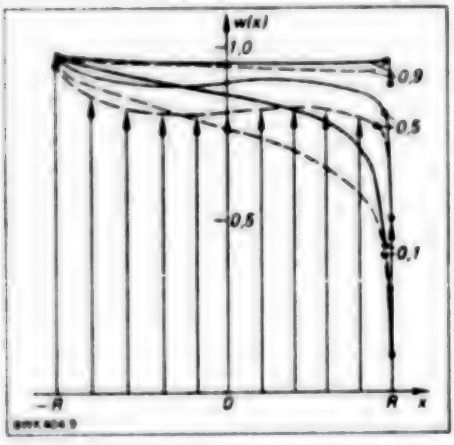

Figure 9. Distribution of the wind velocity w in the y-direction, as dependent on x. When x = +R, wind and rotor move in the plane of the drawing. The parameters are the values of u/w_1. The unbroken lines have been calculated with $NC/4\pi R = 0.1637$, using equation (9), the broken lines with $NC/4\pi R = 0.3274$.

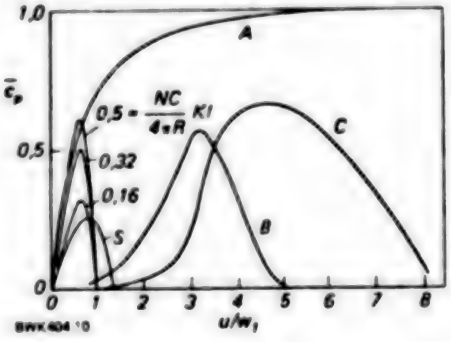

Figure 10. Dependence of the efficiency coefficient $\bar{c}_p$ on the ratio tangential velocity u of the rotor/velocity w_1 of the undisturbed medium. Curve A represents the maximum coefficient for windmills having an horizontal axis.[14] The curves for the Darrieus rotor were taken from references 11 and 17; curve B was measured by G. Binder et al (NC/R = 0.35; Re = 600,000) and curve C was calculated by D.J. Sharpe (NC/R = 0.2; h = 2R; Re = 200,000). Curve S represents the characteristic curve of the Savonius rotor.[14]

According to H. Glauert, the efficiency P of an ideal windmill can reach the maximum value

$$P_{max} = \frac{16}{27} \cdot \frac{1}{2} \rho A_o w_1^3$$

and the maximum value of c_p for an ideal windmill is therefore:

$$c_{P,max} = \frac{16}{27} = 0.593.$$

Therefore, a reduced efficiency coefficient:

$$\bar{c}_P = \frac{P}{\frac{16}{27} \cdot \frac{1}{2} A_o w_1^3}$$

which, ideally, can become $\bar{c}_p = 1$, is often used. Equation (11) has been integrated numerically, which required an iteration for w for each angle. The factor w_1^3 in the denominator of equation (12) introduces only the reduced velocities u/w_1 and $w^2(\phi)/w_1^2$ into equation (11). As a result, Figure 10 reproduces the efficiency coefficients c_p for various equipment NC, as a function of u/w_1. The comparative curves for the Darrieus rotor are taken from references 11 and 17.

If one takes into consideration the rotational energy of the medium at the rear of windmills having an horizontal axis, then the value of $c_{p\ max} = 0.593$ is dependent on u/w_1. This has been taken into consideration in the curve for ideal windmills having an horizontal axis represented in Figure 10.[14]

Numerical Evaluation

Let us first indicate the conditions under which equation (11) has been evaluated. First--as is usual for this model--we have, in the rotor, considered only the deceleration of the wind velocity in the y-direction. A more refined model would also take into account the transmission of impulses in the x-direction. The velocity of the medium in the rotor has therefore a negative x-component. As a result, the angles of attack of the rotor surfaces increase in the rear half-circle.

To calculate the drag and lift forces, we started in equation (1) with the relative velocity of the fluid in the center of the blade, expressed as a sum of the vectors representing the tangential velocity and the wind velocity. A more accurate calculation would take into account the rotation of the blade itself as well as the smaller tangential velocity of the blade edge lying inside the circle, and the larger tangential velocity of the outside blade edge. The blade thus finds itself in a diverging flow for which unfortunately no measured values of the aerodynamic coefficients are available. To this divergence is added the usual divergence of windmills which occurs during deceleration of incompressible flows as a result of the continuity equation.[14]

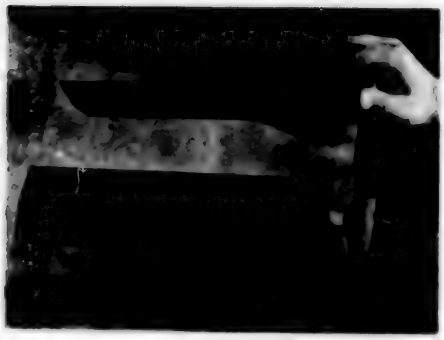

Figure 11. Model built by Ruediger Elies, student of mechanical engineering at the Giessen-Freidberg professional school. The planetary gear is housed in the cylindrical plate.

As can be seen from Figures 3, 4 and 5, angles of incidence α of 0° to 360° occur on the profile selected, in the course of two consecutive revolutions. Unfortunately, the standard work of F.W. Riegels[15] gives measurements covering the full range of angles only for a few profiles. All profiles have a rounded front edge and a pointed rear edge, while the Kirsten rotor requires a profile which is symmetrical when the angle of incidence rotates 180°. In our calculations, we have used the lift and drag coefficients of the NACA 0012 profile which has also been used for the calculations and the construction of Darrieus rotors. A good approximation of the values given in reference 15, page 252, is obtained by the following formulas:

$$c_w = 2.1 \sin^2 \alpha \text{ for } 0° \leqslant \alpha \leqslant 90°$$

$$c_a = 1.13 \sin (2\alpha) + 0.4 \sin (9\alpha) \text{ for } 0° \leqslant \alpha \leqslant 10°$$

$$c_a = 1.13 \sin (2\alpha) + 0.4 \sin^2 (9\alpha) \text{ for } 10° \leqslant \alpha \leqslant 20°$$

$$c_a = 1.13 \sin (2\alpha) \text{ for } 20° \leqslant \alpha \leqslant 90° \qquad (14).$$

The possible dependence of the efficiency coefficients of the Kirsten rotor on the Reynolds number has not yet been investigated.

For his engineering dissertation at the Giessen-Friedberg professional school, Ruediger Elies has built a demonstration model of the Kirsten rotor (Figure 11) and has investigated it in a water tunnel. No attempt at optimization was made. For instance, friction bearings were used instead of ball bearings, and a hydrodynamically unfavorable double-wedge profile was used. In addition, the blades were attached only on one side, as in the Voith-Schneider propeller, so that tilting moments occurred. In spite of that, instead of the calculated theoretical efficiency of 5.9 watts, a value of 3.5 watts was measured. The control of the two blades of the model was ensured by a planetary gear. For

larger windmills, more suitable control shafts are used, which are located in the supporting beams of the rotor and are driven through a weather vane.[2]

Conclusions

As Figure 10 shows, the efficiency coefficients of the Kirsten rotor are similar to those of the Darrieus rotor. Since its maximum efficiency is approximately $u = 0.7\ w_1$, while the Darrieus rotor must be operated at $u = 5\ w_1$, the centrifugal forces are approximately 50 times smaller in the Kirsten rotor than in the Darrieus rotor. The production of Kirsten rotor blades, which are straight, should therefore be cheap. However, this rotor requires more equipment. The sum of the blade chords NC should be approximately equal to half the circumference πR or larger. But the Kirsten rotor provides a high starting torque in any position, even at low wind velocities, and it does not require any auxiliary drive to start. While it is well suited to supply energy at low wind velocities (which are common), it is not limited to such low wind velocities.

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NATIONAL ASSEMBLY CONTINUES DEBATE ON RESEARCH POLICY

Paris AFP SCIENCES in French No 193, 15 Nov 79 pp 7-10

[Report on debate: "Budget, Research, France, Universities"]

[Text] Paris -- Over 4 billion francs for university research. The following details concerning the part of university research were provided during the debate on the budget of the ministry of universities, which took place at the National Assembly on 9 November.

Claude Coulais (UDF), special recording secretary:

Over 4 billion francs or 27 percent of the universities budget have been allocated for university research. In 1980, this research will benefit not only from an increase in the number of scientific jobs (more than 600 positions will be created or improved in the university system and CNRS), but also from an increase in equipment and from organization improvements.

Within CNRS, the yearly rate of increase for equipment budgets is 19 percent for heavy equipment and 17 percent for intermediate equipment, which will make it possible to undertake new techniques aiming at new themes.

Orientation of research toward selected scientific priorities will be assisted.

A policy for scientific decentralization is developing, through assignment of increased means and of 80 percent of newly created research jobs to regional scientific development centers. This is a gentle revolution against the "French problem" in one of its forms.

The university budget is "a good budget because it contains important measures aimed at university adaptation to the missions which France is entitled to expect from its intellectual elite."

Mr Le Pensec (socialist), counsel to the commission for cultural, familial, and social affairs:

"The 1980 budget is one of the worst which the universities have known in the recent past. It is a regressive budget in many respects.

The perenially small equipment allocations for university research entail a slow and irreversible deterioration of our research patrimony.

Inadequacy in creating teaching positions entails rapid obsolescence of our university potential, which will soon result in harmful consequences to the cultural level of the entire country: 83 percent of professors of medicine, 81 percent of professors of literature, 65 percent of professors of pharmacy, and 60 percent of professors of science are over 50 years old. One third of professors of literature and of medicine are over 60 years old.

CNRS reform "raises more questions than it appears to solve."

Jack Ralite (communist) is concerned about the future of mathematics research in France, where it now holds third place in the world, "but which is threatened, because there is no assurance that mathematics research teachers are being replenished at the desirable level. While mathematics research is healthy today, its future is dark if remedies are not applied now. With ten new people out of 3500 mathematicians per year, we are headed toward sclerosis, mutilation, slow but sure sinking."

Emile Muller (UDF sympathizer), in his declarations, underscored "the importance given by the University of Haute Alsace to the opening, in the near future, of an international institute of transportation and communications. A market study conducted in several countries with the help of the Alsace region, and consultation with the international chamber of commerce as well as with international transportation organizations, have shown that the establishment of such an institute answered a genuine need of French and foreign transportation enterprises, since no instruction of this type is available at present.

"Instruction will be oriented toward continuous training of enterprise staffs, and toward basic formation such as diplomas in specialized scientific studies and diplomas in concentrated studies.

Thanks to joint efforts by the city of Mulhouse, the Haut-Rhin Department, and the Mulhouse chamber of commerce and industry, this institute will open as of next year and will constitute the sixth UER (Teaching and Research Unit) of the University of Haute-Alsace."

Alice Saunier-Seite, minister of universities:

On the subject of the Commission for Research and its pursuit of a policy of selectivity, the minister declared: in 1979, the infrastructure allocations distributed on the basis of quantitative criteria amounted only to 18 percent of the total, while allocations based on program and establishment policy justifications reached 82 percent.

Next year, the selective role of the Commission for Research will increase even more, with recourse to consultants who will assist advisors to the leader of the commission, and with scientific hearing procedures which will make it possible to evaluate results on the spot.

On the subject of CNRS, the minister felt that this organization "has been provided with powers of reflection, proposal, evaluation, and verification in order to set general, divisional, or local policies, and to follow up on their application. Budgetary and administrative decentralization will accelerate the scientific activity of laboratories and research centers. For the benefit of Mme Privat, I would also like to specify that this reform has the approval of the greatest scientists. (Mme Privat, (communist), had entered into the debate to state that 'I have heard the following accusations made by scientific universities, by the top engineering institutes which train the national economy's upper echelons: the CNRS reform is perceived as a decision of industrialists and technocrats substituted for that of the scientific community; unfathomable economic planning henceforth presides over the implementation of third cycles; there is a complete lack of dialogue between university authorities and your ministry; an irksome guardianship weighs even now over regional authority; and a sterilizing and outdated authoritarianism exists.')

Mme Saunier-Seite noted that "cooperation between university research and enterprises is increasing, notably at the level of the CNRS relations committee - CRIN (expansion unknown)- and among specialized clubs which are operated by this organization and which investigate research topics suitable for common action; among these topics, I would cite computer-assisted design, automation, lasers, plasmas, mechanical systems, and signal processing."

The minister also cited the example of the ATP (expansion unknown), and she underscored that this cooperation does not concern only large enterprises, but that PME(small and medium-size businesses) and PMI (expansion unknown), as well as service organizations, which were a bit isolated until now, have begun to rely on universities and CNRS. The minister specified that a special information effort has been made by the ministry of universities in collaboration with the industrial press. We have created a mixed discussion group to improve this type of reciprocal information.

The minister added that at the request of the service enterprise association, composed mostly of small enterprises, CNRS is also leading a national survey on the future of these companies, and on their needs in terms of science and innovation. These enterprises are beginning to feel the need to secure the services of executive staffs in the areas of management and commercialization.

The reorganization of the National Agency for Valorization of Research - ANVAR - will result in improvement of that organization, notably with respect to small and medium-sized enterprises wishing to engage in the perfecting of new products and processes.

For the past three years, research has gained hold in engineering schools. In 45 out of about 100 of those schools for which the ministry of universities is responsible, counting private schools, students can prepare a diploma in concentrated studies along with their engineering degree. In other words, they follow a "baccalaureate plus five" curriculum. Afterwards, they can prepare a thesis, thanks to the industrial advance recruiting practiced by some enterprises such as Elf-Erap, and by certain chemical enterprises, or thanks to grants for engineering doctorates. We have awarded 90 of these last year. For this program, the national center for scientific research has organized research training periods of two to three years during the course of studies.

Half of the laboratories of these 45 schools are supported by CNRS. These laboratories represent one third of the new training recognized by CNRS. They involve 7000 people, including 3000 teaching researchers and 1300 doctoral candidates. Keeping in mind that a graduating class numbers 9000 engineers, it can be seen that thanks to this program the number of engineers trained in research has doubled in less than 3 years. We are catching up with great scientific countries such as Germany and Japan.

For documentation and information, we are also going to keep pace.

Until now, university libraries hardly took research requirements into account, and the sums which universities were forced to invest in documentation centers out of their own budgets were far in excess of university library budgets. These amounts were transferred from funds earmarked for other purposes. Henceforth, the libraries will work in concert with the Commission for Research to take the needs of researchers into consideration. Thus the universities budget, and in particular the research section of this budget, will be reinstated in its proper function which is the operation of research in the true meaning of the word.

The University Agency for Scientific and Technical Documentation and Information (AUDIST), established in October 1978, will make available to university libraries and to others, the reference materials acquired and managed by those who are most suited to do so. A year ago, the agency prepared an inventory of French and foreign documentation centers and data banks. It studied the various programs specific to bibliographic material, as well as the accounting of national material. It assessed the National Library's considerable information problems, and defined the library's relations with CNRS. One year after its establishment, AUDIST is ready to operate. This is why its budget allocated was doubled.

For the benefit of Mr Schneiter, I would note that the establishment of AUDIST will not entail a reduction in the means available to university libraries; on the contrary, it will provide general access to complete collections, analyzed by the best specialists. Thanks to the agency, there will be improvement in the management of university libraries and in the information made available to researchers.

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R&D INCENTIVE PRIZE FOR SMALL, MEDIUM-SIZED FIRMS

Paris LE COURRIER DU CNRS in French Oct 79 p 35

/Article: "A Bonus for Innovation"/

/Text/ Established by decree on 13 July 1979, the bonus for innovation is allocated to small and medium-sized firms which subcontract research work to laboratories. It thus concerns the CNRS /National Center for Scientific Research/. Its mechanism is simple: the state will bear 25 percent of the cost of a receipted invoice. It is automatic: the firm need only present such an invoice to benefit from it. ANVAR /expansion unknown/ is in charge of implementing it.

In instituting this bonus, the public authorities were seeking to establish a general incentive procedure for research work and they were most concerned with companies that, either because they are not in the habit of doing it or because of their size or position in the economy, do not have sufficient recourse to the research means of laboratories. These companies must have less than 2,000 employees. They must not be listed on the French or a foreign stock exchange nor have the majority of their capital held directly or indirectly by one or several companies listed on a stock exchange. It is thus a new category of companies, which in general do not have their own research facilities, that are being urged to work with laboratories. It is useful to remember at this point the size of the economic sector concerned. If the proportion of the nation's gross domestic product made by industrial companies is estimated at 42 percent, a little more than half of that amount is due to the activity of small and medium-sized firms. It is they that must be brought into a general movement of technological progress and innovation. Although all of them do not necessarily have highly scientific problems, it may be thought that a certain number, nevertheless, could benefit, in varying degrees, from the experience of researchers, engineers, and technicians from the laboratories of the CNRS.

The projects that can earn one the right to the bonus are fully described in the decree of 13 July 1979. They can concern research on perfecting products or new or improved procedures and also studies for understanding or making models of technical processes. The projects can include surveys,

characterization measurements of parts, calculations for parts or procedures, and the interpretation of industrial test campaigns.

On the other hand, the innovation bonus cannot be applied in the case of projects relating to administration or organization, or in the case of permanent training arrangements. In particular, purchases of material and measuring apparatus are excluded (even if they are necessary for tests ordered), as are pure subcontracting jobs relating to routine checks, bibliographic research, costs of industrial protection and of priority research, and market studies.

The organizations or people that can be called on by the company are fully described in the decree of 13 July 1979: the object of the innovation bonus is to encourage the use of outside facilities, such as public research bodies or scientific or technical experts. But both sides must be approved and this approval is the only condition that calls for a quality judgment by the state in the company-laboratory relationship. For all the rest, the procedure is automatic.

Approval is given by ANVAR after the decision has been made by the aids award commission. The aids award commission is the agency set up to give an opinion to the director general of ANVAR regarding the requests presented for national aid to research and innovation (in particular the aid to innovation established by a separate decree also dated 13 July 1979). Approval can be given in a general fashion for the duration of 1 year renewable to public or private laboratories which request it, on condition that their reputation with regard to research is incontestable (general approval). In other circumstances, particularly for any research agency as well as for experts, approval will be granted for a project in collaboration with a given company (specific approval). Approval can be withdrawn under the same terms under which it was granted.

There are two limitations to the awarding of the innovation bonus: the cumulative amount of bonuses paid must not exceed 1 million francs per year, and the bonus is not payable if the invoiced work has already received public aid in connection with the same program.

This second provision is aimed particularly at the aid to innovation (ANVAR) and aid to research (DGRST) /General Delegation for Scientific and Technical Research/. There are no provisions for a minimum threshold. When a firm has asked for an allowance from a laboratory or an expert, it will be credited with a sum representing 25 percent of the amount, tax not included, of the invoice presented by the laboratory or approved expert.

The lack of any value judgment on the nature of work that is the object of the loan gives an automatic character to the paying of the bonuses. In order to be able to benefit from the bonus, the firm must simply present a request that complies with the criteria outlined above (size and autonomy of the firm, the existence of approval and production of a receipted invoice, no concurrence with other public aid, ceiling of

1 million france per year). The public authorities considered that any value judgment on the work performed belonged to the firm requesting it. Controls have, nevertheless, been set up. They will be exercised on a sample basis, generally a posteriori, and will be aimed at avoiding abuses or fraudulent misuse of a procedure that was set up to be flexible and speedy.

The procedure for the innovation bonus is original. In principle, it resembles the measures to encourage the development of research activities that are practised in the FRG. In fact, it borrows some features from tax measures and it can be interpreted as a negative tax: instead of the transaction between the firm and the laboratory being taxed (payment of tax to the Treasury), it receives a reimbursement (payment of a sum by the Treasury through ANVAR). No total financial ceiling has been specified in the decree of 13 July 1979. Experience alone will be able to tell at what level this incentive should be placed. Since the month of July, ANVAR has been actively engaged in setting up the necessary facilities. The research agencies and firms will be systematically informed of the implementation procedures.

The CNRS laboratories will, in pricniple, all be approved in the terms of the decree of 13 July 1979 in the form of a global approval of the CNRS. Their attention will be drawn to the advantage of a simple procedure that will permit them to establish new research-industry relations, to become better acquainted with the firms, and to encourage these firms to have more recourse to their knowledge. The result of an intensification of exchanges can only be the development and enriching of the activities of both sides.*

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*For all information on the innovation bonus, write directly to the Department of Industrial Relations of the CNRS: telephone 555.92.25, extension 2330.

R&D ON THERMAL STORAGE FOR ENERGY SAVING PLANNED

Paris AFP SCIENCES in French 29 Nov 79 p 18

[Report: "Energy Stocking"]

[Text] Paris--Energy Saving by Thermal Storage. The Colas Road Company has established a branch under the name of Ecostoc for the commercial promotion of thermal storage systems for a temperature below 120°C under study by the Atomic Energy Commissary. The focal point is on facilities having the following thermal storage capacities: solar energy (from 1,000 to 100,000 thermal units), and recovery of thermal waste (100,000 to 100 million thermal units). Such thermal storages may be used whenever the possibility appears to recover heat whose production is not coordinated with consumption (industrial thermal waste in summer, or solar energy, for example). In order to preserve it in a readily useable manner, the heat is taken to underground storage tanks filled with water or other liquids.

The CEA [Atomic Energy Commissary] has made a study of several types of reservoirs and, particularly, with the help of architects Alexandroff and Liebard, of a system consisting of several juxtaposed parts which have been licensed jointly.

In order to ensure the development of this system, the CEA is cooperating with the Colas Road Company whose experience in civil engineering is widely known in France and abroad. Ecostoc will use the Colas company for soil studies and the organization of the facilities for such storage and, whenever possible, for construction work. It will work with the CEA in the area of heat computations leading to a choice of a storage system and its parameters and management; the architectural studies will be entrusted on a preferential basis to Alexandroff and Liebard.

The aim of Ecostoc is to sell, completed, storage containers with guaranteed effectiveness, based on the studies and experiments carried out by the CEA and the knowledge and licenses of the two [illegible]ers.

particularly in the field of split storage facilities, as mentioned, and the "Coletanche" lining patented by the Colas company.

The Colas Road Company and the CEA are jointly implementing a research and development program for the development of the new products.

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PLANS TO REVAMP, INCREASE OVERSEAS S&T ASSISTANCE

DGRCST Activities

Paris AFP SCIENCES in French 22 Nov 79 p 1

[Text] Paris. Toward a DGRCST [General Office of Cultural, Scientific, and Technical Relations] reform. It was already known but Jean Francois-Poncet, minister of foreign affairs, confirmed to the National Assembly, in the course of his 7 November speech, in the course of the discussion of the budget, that a reform is being drafted for the General Office of Cultural, Scientific, and Technical relations of the Quai d'Orsay and, in general, of French policy in these areas of cooperation with foreign countries.

"Aware as I am of the capital importance of this form of presence in the world, which I had called for ever since I came to the Quai d'Orsay, the study in depth of the future of French external cultural relations has just been completed," announced the minister, even specifying that "the date of the government's meeting having been set, it will be possible to establish the major directions before the end of the year."

Jean Francois-Poncet indicated that the report which was drafted contains a number of suggestions to the government "which are of a kind to renovate our cultural activities in the broadest possible sense. This includes teaching, research, development cooperation, intellectual, artistic, and scientific exchanges, promotion of the French language, and even exchange of young people. This implies extensive coordination with administrations which are engaged in such activities domestically."

As to the 1980 budget of the DGRCST, "which has been raised by 13.2 percent," the minister emphasized that "the emphasis was placed on scientific cooperation."

Thus, "scientific services will be strengthened by the opening of 10 additional positions (actually, five positions as councilors or attaches and five administrative positions--editorial note). I consider it normal

that such positions would include everything required for the work of a scientific attache. Let us not build up an army of generals which, alas, is the administration's tendency."

"As to research funding, this year it will go beyond 10 million francs (from the state secretariat in charge of research--editorial note). The fact that it is outside my ministry but that it serves the scientific work which our science attaches are doing abroad does not lead me to lessen its importance."

Overseas Research Funds

Paris AFP SCIENCES in French 22 Nov 79 p 10

[Text] Paris--Five hundred million francs for overseas scientific research. "Funds allocated by the Ministry of Cooperation for Scientific Research Overseas, which largely determines economic development and the struggle with epidemics, will be increased to nearly 500 million francs, slightly over 200 million of which are for the applied research institutes," announced Andre-Georges Voisin, special cooperation budget reporter, in the course of the discussion on this item, held on 12 November.

Nevertheless, Voisin apologized for being unable to describe the specific breakdown of the funds.

In his speech, Robert Galley, minister of cooperation, emphasized the need to "put research at the service of directly productive operations." "Basic research must serve to an ever greater extent applied research, the latter serving development. It is in such a spirit," he specified, "that we intend to use substantial funds. In 1980 they will total 495 million francs or over 10 percent of my department's budget, i.e., about one-half of investment subsidy loans."

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PLANS TO ADVANCE STATE, SHARING OF OCEAN TECHNOLOGY

Technological Advance

Paris AFP SCIENCES in French No 196,6 Dec 79 p 2

[Text] Paris--Industrialists and Ocean Exploitation - The interprofessional group for ocean exploitation, composed of approximately 70 enterprises, has just prepared a study and recommendation report to be used in establishing a national action program in the area of ocean science; this was done at the request of Pierre Aigrain, state secretary for research.

This appears to be the first time that public powers have sought the point of view of the industrialists concerned. This report, together with others on the same topic from organizations such as CNEXO (National Center for Exploitation of the Oceans), ISTPM (Scientific and Technical Institute for Ocean Fishing), or CNRS (National Center for Scientific Research), should contribute to government studies concerning ocean science; this in turn sould lead, it is felt, to redefinition of French policy in this field and to restructuring of specialties.

The report was prepared under the direction of Professor Michel Vigneaux, director of the Geology Institute of the Aquitaine Basin.

Industrial proposals bear on planning and management of the French seaboard and of the economic zone, on the exploitation of maritime environments, on transportation, and on the defense of French interests.

From 16 to 18 January, in Paris, ASTED (expansion unknown) will hold its ninth seminar on the exploitation of the oceans; its four topics will be precisely those of energy and raw materials, living matter, undersea intervention, and preventing and fighting pollution.

Foreign Markets

Paris AFP SCIENCES in French No 196,6 Dec 79 p 3

[Text] Paris--France will develop the exportation of technology related to ocean exploitation--France is going to strive to develop the exportation of its technology in connection with monitoring of the 200 nautical

mile economic zones; this was indicated on 29 November in Paris by Aymar Achille-Fould, president of the interministerial sea commission.

To this end, the commission will implement a "general plan, aimed at coordinating development and export promotion of equipment for economic zone observation and monitoring", as Mr Achille-Fould explained during a press conference.

He stated that the purpose will be to try to secure the markets which will open in the approximately 80 countries that have adopted the principle of the 200 mile economic zone. France can sell its techniques on these markets, implement them, and provide training for those who will be in charge of exploiting this zone.

On the foreign market, the general plan will seek the best means of developing exportation, taking into account the new maritime interest arising in certain countries which were not very industrialized until now. In collaboration with the ministry of foreign trade, the sea commission wishes to develop contacts with industrialists, and to avoid competition between the private and public sectors, as Mr Achille-Fould pointed out.

He added that guidelines will be set, with eventual financial incentives, to "avoid the internal French quarrels which foreign clients sometimes find themselves having to arbitrate."

Within about 3 months, in order to assist industrialists, the sea commission will define the first major outlines of a Guide to the 200 Nautical Miles.

The president of the commission indicated that in the near future the council of ministers would also address itself to problems in ocean science. He emphasized that the last interministerial committee has already set a principle. Each ministry involved with research will maintain its full responsibility, but it is important for efforts to be coordinated in a coherent way.

For this purpose, a committee for ocean science orientation, presided by Mr Achille-Fould, will be established and charged with evaluating priorities, in concert with CNEXO, whose director will become vice president of the new organization.

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GOVERNMENT-INDUSTRY COOPERATION IN ROBOTICS RESEARCH

Paris L'USINE NOUVELLE in French Nos 51-52, 20-27 Dec 79 p 47

[Article by Claude Amalric: "The DGRST is Betting on Robots for Industry"]

[Text] A four-year program backed by "substantial" financing will focus the efforts of public and private researchers on industrial targets: advanced teleguidance, manipulator mechanics, general robotics, and flexible workshops.

The 2.2 million francs which will be allocated on an annual basis over a four-year period for the major robotics project announced by the DGRST [General Office for Scientific and Technical Research] will, unquestionably, be insufficient for the completion of such an ambitious project.

There will be no surpluses if the project is to be carried out: organizing 4,500 public or private researchers to cooperate on specific topics involving medium and long-range industrial targets and providing them with the rather expensive necessary equipment for such research.

By virtue of the number of personnel and facilities at its disposal the CNRS [National Center for Scientific Research] will play a pilot role in the matter. "However, it will not be a supervisor," emphasized Combet, in charge of the project at the DGRST and, on this basis, in charge of financing. Actually, most of the state research organizations will involve at least one of their laboratories--CEA, CNES, ONERA. . . The same will be the case for the big machine and electronics enterprises. Between these two, engineering schools will also become involved in the project.

The researchers are faced with [illegible] major topics: advanced teleguidance (telemetric manipulator, for example), mechanics and technology (mechanisms and control of light industrial manipulators), general robotics (developed command, complex manipulation, automatic inspection, and development of work-adapted systems); the last topic: systems of

flexible production workshops--should result in the development of formulas for exploitation and materials making it possible to automate a type of output variable in terms of nature and quantity: thus an important base for product competitiveness has been given priority. Renault could be the pivotal factor of this study.

The very strong desire to develop close links between researchers and industrialists augurs well such activities now in their beginning.

What are its foundations? Work under contract as described in the accountability discussion held at the start of the month in Sophia-Antipolis (the 6th) shed some light on the subject. Whereas some research projects might have looked like university games (how far to push theory and when should experimentation leave the laboratory?), others, conversely, proved the extent to which industrial reality concerns researchers: flexible transmission of motions without loss of precision, clamps mounted on the clips of a manipulator rather than on its "shoulder," and electric motors with several degrees of release, developed at the technology university in Compiegne, for example. Let us not forget Hilare, the research support robot of the LAAS in Toulouse, whose spectacular appearance conceals a systematic evaluation of ideas such as looking for an optimum itinerary, along with components such as clips, activating systems, and recovery systems. Hilare is available to any interested researcher.

Abundance of Ideas and a World Premiere

Richelet, president of the Industrial Robotics Committee of the DGRST, regretted, in his conclusions, the great amount of duplicate research. The present project would eliminate this.

He also noted, however, "a multiplication of ideas many of which were not in the contract program." This was a good point. "For the first time we have seen real robots." This was certainly the case of the submission by Comex, in Marseilles, of a system for circular automatic welding of a pipe submerged at a great depth (1,200 meters). This is an operation frequently requested and, so far, with no machine to perform it. It has a big market and it is a world first.

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ADVANTAGES OF NEW METALLURGICAL TECHNIQUE

Paris L'USINE NOUVELLE in French Dec 79 p 12

[Article by Jean Roume: "A New Steel-Making Method"]

[Text] The discovery that an electric furnace or a converter are put to better use when they are made to produce first "raw" steel which is then refined in a pocket means to give birth to a "new metallurgy:" pocket metallurgy.

Five years ago this was not a topical subject. Five years from now the Western pocket metallurgy market will be, unquestionably, close to saturation, for most metallurgists will be forced to adopt this new steel manufacturing method." This prediction was made by Gabriel Lamarque, director of the elaboration-refining department of Heurtey Metallurgie. Together with Paul Gosselin of the Societe des aciers fins de l'Est (Safe), he is the "father" of French pocket metallurgy.

Joseph Farhi, chief of the steel plants services at Sofresid, backed this view: "Pocket metallurgy is becoming widespread. In the course of our studies for a new steel plant 95 percent of our customers asked for a small facility for the production of pocket steel and the necessary facilities for a subsequent complete processing."

Gabriel Lamarque and Paul Gosselin started in 1970 from zero, for the Safe had purchased an American license for the handling of such problems, which turned out to be unuseable. As was generally the case in fine metallurgy, the company refined and varied its steels with the help of electric furnaces. In order to increase output the purchase of a third furnace was necessary, unless the installed furnaces could be used only for the fusion of the iron and carry out all the steel production operations outside the furnace, in a pocket: removal of foreign bodies, reaching smelting temperature, stirring, vacuum degasification, addition of carbon, and alloy elements, etc. This technical gamble succeeded. Without an additional electric furnace, the average daily output of Safe rose from 671 tons in 1974 to 830 tons in the first months of 1978. That year the average cost per ton of steel dropped by 80 francs.

With the latest improvements of the electric furnace (increased power, cold lining), according to Gabriel Lamarque and Joseph Farhi, pocket metallurgy has become a requirement in precision metallurgy if one wishes to remain competitive and put on the market superior quality steels. Electric or induction furnaces can still be used without a problem only for heavily alloyed steels made in small quantities and for special purposes.

However, the benefits enjoyed by quality metallurgy as a result of pocket metallurgy may be applied, at least in part, to the merchant steels: "Currently," thinks Gabriel Lamarque, "a metallurgist who is not engaged in pocket metallurgy or does not consider the benefits of this new method is penalized." The only exceptions today are the small steel plants which could hardly show a profit in the manufacturing of concrete steel and the integrated units using nonphosphoric mineral, for the development of steel varieties in furnaces is relatively simple. However, we cannot exclude the fact that the new requirements of the users, particularly for shaping machine steels, would not encourage the production of "raw" melted steel in a converter, subsequently treated in a pocket in better conditions.

Conversely, the new equipment currently acquired by metallurgical enterprises in Lorraine, force it to combine them with pocket steel processing. The presence of a highly oxidizing phosphorus-containing slag requires that the steel be smelted at a relatively low temperature. This was compatible with ingot casting but is no longer with continuous casting machines. That is why we should not be surprised that Seremange (Sollac), Gandrange (Sacilor), Rehon, and Neuves-Maisons (Usinor) are among plants which have either installed or ordered this year pocket metallurgy equipment together with producers of fine and special steels such as Creusot-Loire and Allevard.

Moderate Investment

Therefore, a "new metallurgy" is beginning to develop, the more rapidly since the necessary investment, ranging 30 to 50 million francs, is quite moderate compared with the cost of other steel-making equipment. Productivity increases, currently well known in fine metallurgy, has still not been properly evaluated in heavy metallurgy, for the gross cost of operation of the pocket (up to 50 francs per ton!) would be amended by better performances to be hoped through continuous casting, hot and cold rolling, and, generally, in the course of the utilization of the steels.

Finally, let us emphasize that, contrary to a number of recent innovations in metallurgy, this one was born in Europe and that French

technicians have shared with the Asea-SKF (Sweden) the leading role in the development of the system. Heurtey Metallurgie has currently received orders for 11 pocket metallurgy systems, some of which to be exported. This is an amount of work appreciated by specialized builders currently.

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PROSPECTS FOR ALTERNATIVE ENERGY SOURCES REVIEWED

Rome FONTI DI ENERGIA ALTERNATIVE in Italian No 3, May/Jun 79 pp 5-11

[Article by C. Caputo, Institue of Machines and Mechanical Technologies of the University of Rome: "Energy Sources" Problems and Trends--Prospects of Non-Traditional Energy Sources for Italy" (Excerpt, revised and updated, from speech delivered in course of round-table conference on nontraditional sources of energy held in Ancona during the 30th National Congress of the ATI [expansion unknown], September 1978)]

[Text] The energy crisis in which we have found ourselves since 1973 is not anything new, because other energy crises have followed one another in the past with a certain periodicity (the last one was in the 1950's). The new fact is that this time, not only a small circle of technicians but all of society has been sensitized to the problem, both because it is a crisis that is increasingly disturbing with the passage of time (because of the exponential growth of needs) and because today it has to do more with the cost of fuels[1] than with the effective resources. This, of course, is without any desire to ignore the objective truth that, independently of their extent, the reserves of fossil fuels are not renewable. And there is also the consequent ethical principle that does not give a few generations the right to tap, on a purely hedonistic basis, a quantity beyond all measure of a natural patrimony which, wisely managed, could meet the needs of a great many generations.

As in other circumstances of this kind, for some years, then, while an attempt has been made to impose a rational energy policy, aimed at limiting consumption and ending waste, a look is being taken again--and with closer attention than ever--at the alternative energy sources.

Closer attention is being paid for many reasons. First of all, the technological level now reached makes it possible to try approaches that earlier seemed inaccessible; and secondly, the present higher costs of energy from traditional sources make energy sources competitive today which were not so before. Finally--and this is very important--society is acquiring awareness

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1. Although the real costs actually have not increased notably in the last decade.

of its relationship with nature, and is finally learning to respect the environment and its resources. People are aware today of the fact that burning 1 kg of fossil fuel means destroying inconsiderately a patrimony which nature has taken hundreds of millions of years to build up. And this understanding, together with knowledge of the effects of combustion on the environment, is leading people to look favorably on the renewable sources of energy.

Among the traditional sources, only hydraulic energy is renewable; but it is too scarce--worldwide, it covers only 10 percent of the needs, and even in Italy, where the percent is around 30 percent, one barely manages to meet the peak requirements with it.

Thus there is no alternative but to turn to the nontraditional sources, of which there are many in prospect, some of them very attractive.

Understandably, the enthusiasms in this field are conquering not only the innumerable impassioned inventors but also the most objective technicians, who with each new energy source are predicting the possibility of covering a certain percentage of the current needs. The percentages really vary widely, but this is not surprising; any figure is good, and can be achieved in principle, if the source is promising, depending on the commitment made to develop effective utilization of it. It is clear that without adequate commitment, any result has a marginal destiny in store for it at the outset, and as regards Italy--which needs alternative energy sources more than other countries--there is the risk of having to pay in royalties on new technologies tomorrow what we are paying today for importation of fuel.

A choice has to be made at the outset: that of a range of sources to concentrate on with a massive effort, an effort calling on all of the nation's research resources. It is obviously useless to talk about tidal power, which, though of interest elsewhere, does not offer any prospects to us except perhaps the prospect of encouraging extraction of uranium from the sea, which contains it in the measure of 3.3 mg/m^3 (in Japan since 1978, a project financed with 2 billion to JAMSTEC--Japan Marine Science and Technology Center--is aimed largely at developing this possibility).

Likewise, various other alternative sources--such as, for example, the use of marine thermal gradients--do not appear promising for us. Some, such as wind sources, for example, merit attention, but because of the characteristics of our winds and the wide scattering of the source itself, wind power in future will be able to play a marginal role only.

In arriving at the basic choice referred to above, it is advisable to consider preferentially, in the writer's opinion, those new energy sources of which any one would make it possible, in prospect, to cover the entire national needs. This is a criterion of choice that certainly does not aim to supplant, by the use of a single source of energy (and a newly minted one to boot), the use of all the others; we are convinced that the new sources must be integrative, not substitutive. But it is a criterion of choice that furnishes a spec-

ific relative measurement--in relation, that is, to our present needs--of the potential productivity of the source in question. Whether, then, this potential productivity is utilized to a greater or lesser degree is a matter of energy policy and economic policy.

Everyone understands that several energy sources must necessarily coexist and that, for obvious reasons, an energy system must be well-balanced overall.

Nonetheless, the condition set above is such as to justify the necessary commitment to research of which we spoke above, and the massive financial efforts necessary to bestow real significance as economic investment at the outset.

Among the numerous energy sources in Italy, there appear to be only three that meet the condition of quantity referred to above: solar energy, geothermal energy, and the energy connected with the wave motion of the sea.

A. It is unnecessary to go on at length about the possibilities offered by solar energy, because mountains of material have been written on the subject and on the modalities of conversion of radiant energy. The use of this source for heating and air-conditioning of enclosed spaces is already an industrial fact, while its use for production of useful mechanical energy is already at an advanced stage of research.

Italy is favored by its geographical position: it is southerly enough to get lots of sunshine, and northerly enough to be industrialized.

Taking account of its latitude, cloud cover, and so on--and postulating an overall conversion efficiency of 10 percent, certainly not overoptimistic--our country can count on, in round numbers, 100 kWh per year per m^2 of exposed surface. One two-hundredth of the national surface area ($301,245 \times 10^6$ m^2 : 200 = $1,500 \times 10^6$ m^2) would produce $1,500 \times 10^6 \times 100$ = 150 billion kWh per year--that is, a quantity of energy close to the present needs. Therefore, the condition of interest is more than filled.

Even without verifying or imitating some very bold proposals formulated in the United States, for example, there is no doubt that large segments of territory in Italy can be devoted to capture of solar energy, not to mention the possible use of marine mirrors also for this purpose. Indeed, more than one-fourth of the national territory is mountainous and unproductive: most suitable for the use in question. Solar concentration plants could be located there, in which the radiation produces heat of high quality (thus useable with high output) and--after subsequent conversion--daytime electrical energy, of great value to industry.

In any case, a good part of the utilization of solar energy could be distributed over the national territory, without the need of interconnections, for numerous isolated applications. For example, a house with a base surface area of 100 m^2, with two storeys (≈700 m^3), housing 6 persons, can have more than 100 m^2 of exposed surface area. Thus, 12,000 to 15,000 kWh per year can be

produced, albeit with sophisticated conversion and storage installations--that is, a quantity of energy that makes the social nucleus self-sufficient, taking into account the fact that the average Italian per-capita consumption is on the order of 2,000 kWh per year, which for 6 persons totals 12,000 kWh per year.

Thus, no proportion of centralized and distributed electrical energy is added the use of solar energy (foreseeable, in quantitative terms, as being on the order of 30 percent to 50 percent of the former) for space heating and air-conditioning uses. But while this latter use is already often competitive on the economic level, the same cannot be said for conversion of radiant energy into electrical energy.

Unfortunately, the installation costs for production of electrical energy from the solar source are still prohibitive, and only a massive effort in technological innovation will be able--in a future that also might not be very far off!--to set electricity production on the direct road to the sun.

3. Geothermal energy, though, could be even more promising than the solar source in the medium term. We are already the first to use it, followed by the United States, New Zealand, and--at a distance--the Mexicans and the Japanese. Our territory, rich in this resource, is already furnishing it for extensive uses at Larderello and at Monte Amiata, where 2.6 billion kWh per year is being produced and put entirely into our rail system.

So far, this amounts to only 1.6 percent of national needs, but research is being conducted actively in new areas: in Tuscany, at Travale-Radicondoli, Monticiano-Roccastrada, Poggio-Cortevecchia, and in the Volsini Mountains (even on the Umbria and Lazio slopes); in Lazio in the Cimini Mountains, in the Sabatini Mountains and in the Alban Hills; in Campania at Roccamorfina and in the Campi Flegrei; in Lucania and in Puglie, on the Vulture.

This exploration concerns hot-steam sources, easily and directly useable for production of energy; but in the long term, certainly more interesting is the energy source connected with exploitation of hot rocks, by means of water flows that act as intermediaries between these rocks and the user installations: electric power plants or users of other types, depending on the maximum temperature obtainable from the vector fluid.

In various regions of Italy, the geothermal gradient is higher than the canonic gradient of 25° C per km of depth, as is also the case in the Mediterranean-East Africa strip, the Middle East-India-Australian islands strip, and the Indochina-Far East-west coast of America strip.

In the earth's surface stratum to a depth of 10 km, hot rocks constitute an immense source of energy, estimated at about 1.2×10^9 kWh extractable for every km^3 of rock.

This is not the place to go into the subject of the types of plant and the drilling criteria presently under study (using turbines, fusion, erosion, etc,

none of which is yet economically suitable), nor into the problems of stability and corrosion of the shafts. The technology in this field is decidedly immature. Only the Americans (USA) and the French are trying to develop it, and it is painful to note that competencies well-known to exist are not being made use of by us, who are particularly concerned.

It remains, therefore, only to illustrate the attractive prospects: for example, extracting a good 14 MW of mechanical power for every km^3 of rock (postulating an overall output of 10 percent) for the duration of a century, without substantially disturbing the ecothermogeolcgical situation of the ground.

At a depth of 4,000 m (not far, that is, from the depths reached by oil drillings today), where the temperature of the rocks is not less than 135° C, a basin of 100 km^2 would produce at least 30 MW for every m^3 per second of vector water--and continuously, over a period of nearly 700 years. And the temperature of the deep rock, at the end of the entire operation, would have dropped only 15° C, not taking account of the geothermal equilibrium effects that would simultaneously occur to moderate this temperature differential.

Thus there is no need to fear that the geothermal source does not meet the condition of quantitative interest as defined at the start. But political sensitization to this energy source is still lacking, and unfortunately it is lacking in the technical world of energy also. It is to be hoped that this sensitization will not be too late and that we will finally wake up to the fact that the solution of our energy problems is not coming from the sky alone (solar energy) but also from the immense patrimony under our feet.

In 1966, the Americans commenced geothermal energy research, but it is not given us to know how much effort is being aimed at the hot-fluid sources and how much at the exploitation of hot rocks. The experimental territories are El Salvador, Kenya, Chile, Nicaragua, Ethiopia, and recently New Zealand (Wairakei).

C. The third energy source of interest to Italy is of no less interest than the others: the energy connected with the wave motion of the sea.

For use of this energy source, we are again--as with the preceding ones--in a privileged position. We have more than 8,000 km of coastline delimiting barely 300,000 km^2 of territory. Very few states (for example, England and Japan) enjoy similar ratios between coastal extent and territorial area, but our privileged position is more substantial, because our peninsula faces a closed sea, where the undulation covers narrow ranges of amplitude and frequency, and does not, as elsewhere, reach sporadic extremes such as to imperil plants that might be installed.

In other words, it would be very difficult to find a country anywhere in the world in which the energy of the wave motion of the sea could be utilized more advantageously.

The resource is immense, and amply satisfies the condition of interest as initially defined.

The maximum wave height (between trough and crest), which in the ocean is 18 to 20 m, does not exceed 9 to 10 m in the Mediterranean--which, as we have said, guarantees the integrity of capture structures that are not excessively expensive. Although the oceanographic studies in this regard are not yet complete, it seems that an annual average wave height of 3 m can be counted on near the Italian coasts (Bossolasco and Dagnino, Geophysical and Geodetic Institute of the University of Genoa, 1957-1969), to which corresponds an average annually available power of about 50 kW per meter of wave front.

The duration curves drawn by some authors give lower values, but the most pessimistic speak of 30 kW per meter, and this available power is already of mechanical type and therefore not such as to require conversion (as for solar and geothermal energy), but only transformation, with output therefore high.

Even postulating 15 kW kW useful obtained per meter of wave front, every meter of coastline would furnish more than 130 MWh per year, and every kilometer, 0.13 million kWh annually. With reference to the initial condition of interest, the commitment of one-eighth of the nation's coastline would meet our national electricity needs, and this agrees with the English forecasts, which are even more optimistic because of the greater undulation near the British coasts. However--it is useful to repeat--it would be a mistake to consider the new source in question a replacement for the traditional ones, even if it might be usable in a shorter term than the preceding ones. This source too is to be understood as integrative: useful, at least in an initial phase, for supplying energy to the islands that it is expensive to supply in other ways.

Exploitation of marine undulation excited the imagination of inventors especially around the year 1920, when Fusenot built at Monaco, under a Romasky patent, a small float plant designed to supply the prince's aquariums, using pumps. Great Britain, always attentive to these problems, filed an average of three patents per year from 1860 to 1900, and a good six patents per year from 1900 to 1930. After a period of inactivity, an average of one patent per year has been filed from 1935 to our day.

There is now news of several hundred patents, but many are repetitions of the same substantial ideas, and many of the proposals are not valid; thus, the storehouse of worthy proposals amounts to a few dozen approaches worthy of consideration.

Of these, several concern the utilization of waves in low water (the so-called breakers), and for the most part reflect the old concept of the hydraulic ram, in mechanical or pneumatic form, with the possible addition of suitable barriers capable of concentrating energy. Several of these proposals tend to exploit the pressure variations which the breaking wave produces on the sea bottom.

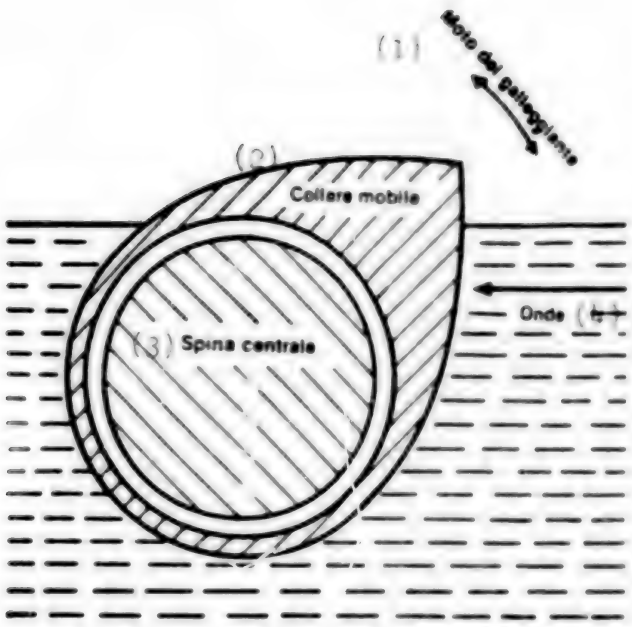

Figure 1. Diagram of the Salter oscillating-cam system

Key:

1. Motion of the float
2. Mobile collar
3. Center pin
4. Waves

However, most of the systems conceived involve the use of the surface waves, the height of which, that is, although considerable, is small in relation to the depth of the bottom.

The number of proposals advanced in this field is so great as to make it inadvisable to list them here. Only a classification should be attempted.

It is useful to distinguish first of all between the tied mechanisms and the free mechanisms. The former (the Monaco archetype was of this class) base their functioning on the interactions produced between a structure subject to wave motion and another fixed to the bottom (for example, the Salter system, Figure 1). The latter, though, take advantage of the inertial actions which a floating structure undergoes in periodically changing its position or its trim because of the undulation.

There is no doubt that, in principle, these latter are to be preferred, because in the sea, any tying-down is detrimental.

But to these classes of apparatuses we must assign subclasses. For example, when we speak of tied mechanisms, the tie-down does not necessarily have to be placed on the bottom.

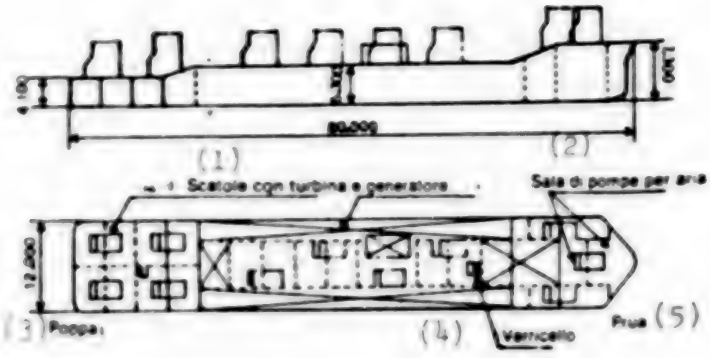

Figure 2. Schematic views of the Kaimei prototype (Masuda pneumatic system)

Key:

1. Housings with turbine and generator
2. Air-pump rooms
3. Stern
4. Winch
5. Bow

A large floating structure can also constitute the tie-down of mechanical or hydraulic systems (for example, the Masuda system, Figure 2) sensitive to undulation, or a floating system can serve as the tie-down for another one (for example, the Cockerell system, Figure 3).

A classification can be made of the mechanisms under discussion according to whether they function on the surface or submerged. The former--working on the surface--take advantage of the periodic movement of floating structures (with hydraulic, mechanical or electrical utilization of the energy captured), or else (still by use of the energy in hydraulic form) they convert marine undulation into stationary undulation. The latter--acting underneath the sea surface--are designed to use the pressure variations created in depth by the wave or the periodic motion (horizontal and/or vertical) of the liquid particles.

No matter what the mechanism adopted for transforming the wave-motion energy into useful energy, it is universally agreed that small sea-motor units should be built, with power on the order of 1 MW, possibly to be used in combination in areas of wave-motion exploitation. It is also agreed that conversion into electrical energy should be done in each producing unit, so as to simplify the problem of connections.

The chance of utilization of the wave motion of the sea seem far more affordable than those for use of solar energy and geothermal energy. Furthermore, while on the one hand there is uncertainty about the optimal system for capturing the energy of wave motion, on the other hand there is the advantage of possible results in the shorter term without the use of still unknown technologies.

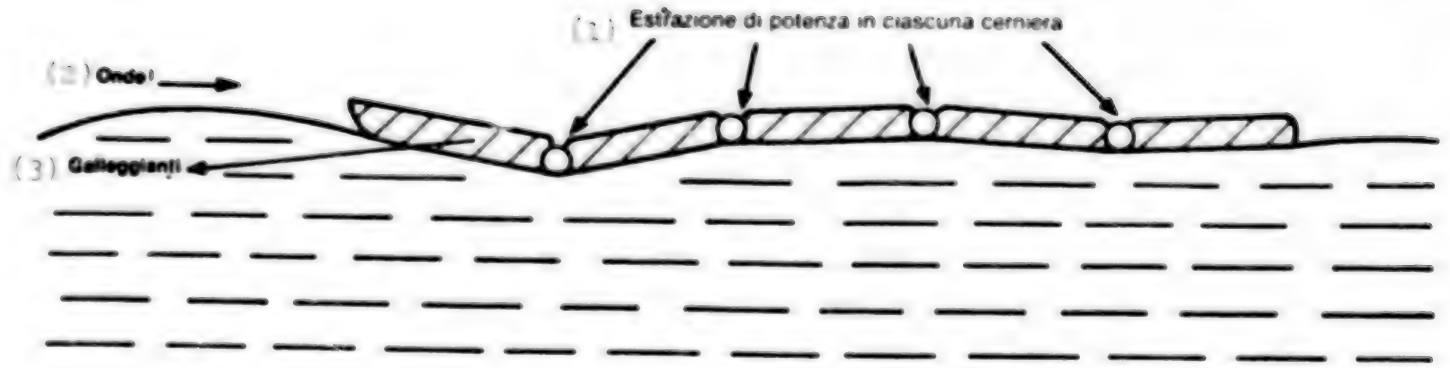

Figure 3. Diagram of Cockerell articulated-raft system

Key:
1. Extraction of power in each hinge 2. Waves 3. Floats

After many studies, the English (who for some time have been in the lead in this sector) have quantified the installation costs for technically applicable systems at between 300 and 800 pounds sterling per installed kilowatt (900,000 to 2,300,000 lire), with consequent cost per kWh produced falling between 1 and 8 pence per kWh (17 to 130 lire per kWh). The more reliable and suitable capture systems have costs of 700,000 to 900,000 lire per kWh installed, with an anticipated cost per kWh produced on the order of 25 to 30 lire, which is in the range of the present cost of energy of petroleum origin and is certainly interesting in view of the unfortunately clear outlooks for the future.[2]

It can be confirmed today that a sea-engine power plant is at this point in time economically feasible up to a cost of about 1.5 million lire per kW installed--a limit destined to increase in a short time.

While the concrete possibility of obtaining energy from the waves of the sea is considered by those in Italy who know about these matters as little more than a scientific curiosity--so far deemed worthy of

2. We should mention in passing the truly optimistic cost of the Masuda type of sea-engine power plant, for which a proposed 1-kW unit would cost barely 850,000 pounds sterling and would produce at a cost of about 0.8 pence per kWh, equal to 10-15 lire per kWh.

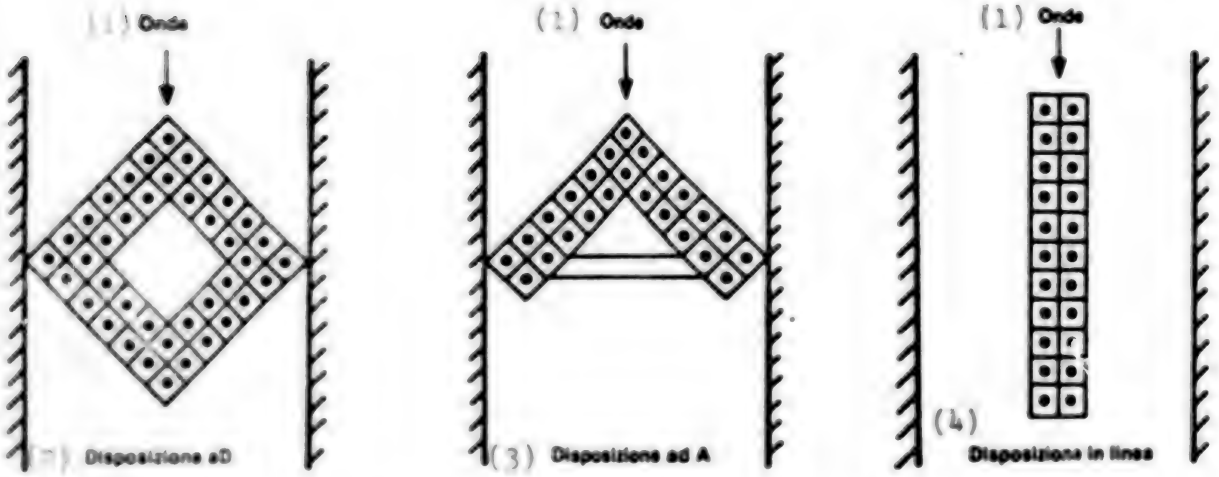

Figure 4. Typical arrangements of the pneumatic units tested by Masuda in Japan

Key:

1. Waves
2. D-type arrangement
3. A-type arrangement
4. In-line arrangement

...plin financing, monopolized by the Tecnomare Company of Venice--the situation is quite different abroad. Great Britain still ranks highest in its interest, but Japan has recently joined in with activities that demonstrate on its part also a real political will to achieve significant results in a short time.

In June 1977, the white paper "The Development of Alternative Sources of Energy," presented by the English secretary of state for energy, Anthony Wedgwood Benn, announced further financing of 4.5 million pounds sterling (more than 7 billion lire) for the study of wave motion, wind energy and geothermal energy, to be added to about 13 billion pounds sterling previously appropriated under the same headings.[3]

The greater part of the new fund is aimed at utilization of wave motion, on which an interesting technical-economic study has already been done by National Engineering Laboratory of Glasgow, on commission from the government Department of Industry. Two pilot installations using the Cockerell articulated-float system are presently in operation: one on Loch Ness in Scotland, and the other near the Isle of Wight, off southern England. It is reported that an industrial-scale plant will go into service next year, still on an experimental basis, while studies on the Salter system continue.

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1. Separately, 1.5 million pounds sterling (2.4 billion lire) has been appropriated for tidal projects: Severn estuary.

Japan, though, has gone decidedly toward the Masuda pneumatic system, with the object of combining many small sea-engine stations in simple geometric arrangements (Figure 4).

An experimental station (Kamei prototype) has already been built near the Yura Gulf on the southern coast of Honshu island, and a new high-power version of the same unit is presently under study.[4] Seven hundred thousand dollars has already been spent for the first version (=600 million lire), and $4 million (=3.4 billion lire) has subsequently been appropriated for completion of the experimental operating unit. The research is being done by private firms (Ishikawajima Harima Heavy Industry Co, Ltd, and Fuji Electrical Co, Ltd), with contributions from JAMSTEC.

As solar energy, sea wave-motion energy has ecological characteristics: in the last analysis, using the latter means using the former indirectly, because it is solar radiation that creates the winds, and it is the winds that create marine waves. But such indirect utilization makes it possible to take advantage of the enormous energy flywheel constituted by huge masses of water available at no cost and of the strong concentration due to the density of the vector liquid. Furthermore, the energy taken from the waves makes the sea calm downstream from the installations and makes the anchorages secure.

Finally, as already stated, the technologies for exploitation of wave motion are not unknown, and with immediate action, could be perfected by ourselves without producing subjection to foreign countries. In this possibility lie the promising prospects for this energy source, about which little is said, unfortunately, perhaps because it has not yet attained to a sufficient level of credibility among our technicians and especially our politicians.

But there is no doubt that potentially, the three energy sources discussed constitute an immense patrimony, and it would not be surprising if, some time in the future, the unquestionable fate of the nonrenewable sources of energy made Italy, who is very poor in them, one of the richest countries in energy produced from new resources.

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4. This involves a large pontoon, 80 m long and 28 m wide, with diaphragms across it, anchored on a bottom 40 m deep. Some of the chambers between the diaphragms provide for the support of the pontoon, and the others--initially 8 and later 10--do not have a bottom and serve as air-compression chambers. The power of each unit, with wave height of 4 m and period of 7 seconds, is estimated at 4,000 kW.

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SWEDEN'S LEGAL, FISCAL RESEARCH INCENTIVES REVIEWED

Paris LE PROGRES TECHNIQUE in French No 15, 1979 pp 33, 34

[Article: "Tax Incentives for Research in Sweden"]

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Legislative Aspect

In 1973, the Swedish parliament passed legislation on tax deductions which could be granted to those industries which carry out research and development projects (SFS [expansion unknown] 1973: 421, see Text of law). The essential element of this law concerns the determination of a base figure on the basis of which two deductions are established, the one an ordinary one and the other a so-called supplementary one, equal respectively to 10 percent of the base figure and to 20 percent of the increase of this figure from one year to the next.

In addition, it should be noted that in 1975 -- in the same spirit of recourse to tax deductions to stimulate research and development projects -- the Swedish government issued a decree affecting all enterprises and setting up a list of research bodies entitled to receive grants which are subject to such deductions.

Consequences of these Measures

A study was carried out by the Swedish Office of Public Administration Inspection (Riksrevisionsverket) at the request of a study committee on tax deductions to further research and development projects, a committee which was set up in December 1978 by the Ministry of the Budget and entrusted with the responsibility for preparing a bill which would eventually, during 1980, replace or supplement the current text.

This study makes it possible to make clear the amounts of the deductions, either globally or in function of the size and kind of activity of the enterprise. The global study focusses only on the year 1977; the results of the previous years were not evaluated.

Total Volume of Deductions

The total volume of deductions benefiting the enterprises for the 1978 tax return (thus, for the fiscal year 1977) was equal to 371 MCRS [million crowns] (1 CRS = 1 French franc).

This sum was divided up into ordinary deductions and supplementary deductions, in the manner indicated in Table 1.

TABLE I

Branch	Amount	Percentage
Ordinary deduction (10 percent of base figure)	304 MCRS	82 %
Supplementary deduction (20 percent of the increase of base figure)	67 MCRS	18 %
Total	371 MCRS	100 %

The above mentioned figures allow one to deduce that the base figure for 1977 was 3,040 MCRS and that it had increased by 335 MCRS compared to 1976, that is to say by approximately 11 percent. According to paragraph 4, first clause (see Text of law), one finds that the expenditures on wages allocated to research supported by those industries which benefited from the application of this law, amount to 1,824 MCRS.

Development of Deduction Volume

The figure of 376 MCRS for the fiscal year 1977 should be compared to the figure of the year when the law went into effect. As a matter of fact, for the fiscal year 1974, 1975 tax return, this figure amounted to 287 MCRS, which implies an increase of approximately 30 percent over the three first years of application.

Effect of Enterprise Size

Among the industries which, in 1977, most benefited from this possible tax deduction, the first ones listed are those whose size is greater than 1,000 employees, then those whose size is between 200 and 999 employees (Table II).

TABLE II: Distribution of the amount of deductions for the fiscal year 1977 according to the size of the enterprises

Number of Employees	Deduction in Rounded Off Figures (in MCRS)
0 - 19	3
20 - 49	0
50 - 199	24
200 - 999	64
1000 - 1999	52
2000 and over	226

Distribution by Industry Branch

A summary distribution, not in conformity with the SNI [expansion unknown] normalization which is used in all Swedish statistics, was adopted as a preliminary measure by the Office of Public Administration Inspection. Table III provides a distribution of significant deductions by branch.

TABLE III: Distribution by branch of industry of the amount of deductions for the fiscal year 1979

Branch	Amount of deduction (in MCRS)	Percentage
Mechanical engineering industry	232	62.5 %
Chemical industry	40	10.8 %
Paper and cellulose	30	8.1 %
Iron and steel industry	25	6.7 %
Quarries	7	1.9 %
Food industry	6	1.6 %
Administration of water, gas and electricity	6	1.6 %
Banks and insurance companies	5	1.3 %
Construction	5	1.3 %
Retail trade	4	1.1 %
Agriculture and forestry	4	1.1 %
Mines and mineral products	3	0.8 %
Etcetera.		

Text of Law

Contents of the law on tax deductions in case of pursuit of a research activity.

. This law is applicable to taxpayers who have an industrial production and who, during the period 1973-1980, have supported research and development projects.

. Taxpayers, as defined in paragraph 1, may, when calculating the profits, take advantage of tax deductions in function of expenditures related to research and development projects of a scientific and technical nature and which can be recognized as important to society because they make it possible to produce new or substantially improved products, processes or production systems.

This deduction must appear on the profit statement immediately following the calendar year during which the expenditures in question were incurred.

. The tax deductions for research expenditures consist of an ordinary deduction and a supplementary deduction.

The ordinary deduction and the supplementary one constitute respectively 10 and 20 percent of the base figures calculated according to paragraph 4, respectively first and sixth clauses. In order to take advantage of these two kinds of deductions, the base figure for each of them must be at least equal to 5,000 CRS.

Only those who received an ordinary deduction the previous year may take advantage of the supplementary deduction.

. The base figure for calculating the ordinary deduction is set at 5/3 of the costs, carried by the taxpayer during the calendar year, which were allocated to salaries or various benefits (food, lodging, etcetera) related to the personnel employed by the taxpayer for research and development projects. As defined in paragraph 2.

The estimated cost of the salaries should take into account only the percentage of the activity devoted to research and development, and should not under any circumstances surpass the amount of the employer's tax (determined by the 1968-419 law) for an equivalent length of time of work.

The base figure for calculations shall only include the salaries of those employees who are primarily occupied with research and development tasks.

The deduction may be increased by subsidies granted by the taxpayer during the year in question, and by the costs resulting from the acquisition of the results of research and development projects. It may be reduced by the sums received either as aid to research or through a transfer of the results.

The costs and subsidies related to research and development projects carried out abroad, and in total exceeding the sum of 250,000 CRS, must be taken into account in calculating the base figure.

The base figure for calculations of the supplementary deduction is obtained by figuring the increase, during the calendar year, of the base figure used for the calculation of the ordinary deduction as compared to the equivalent sum for the previous year.

. The taxpayers can take advantage of these tax deductions only by making a specific request, accompanied by the supporting documents, at the time of turning in their tax statements.

. Deductions for research costs are calculated in a specific way for trading companies or those with limited partnership.

This law went into effect at the time of taxation for the year 1974. Thus, it was possible to take advantage of the supplementary deduction for the first time only the next year.

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